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[OFFICIAL NOTICE.]

Annual Meeting, American Gas Light Association.

LAWRENCE, MASS., Aug. 28, 1889.

Section 12 of the Constitution is as follows:

"Section 12. *Application for Active Membership, or for Associate Membership, or for transfer from Associate to Active Membership, must be received by the Secretary at least ten days prior to the meeting at which the application is acted on.*"

To the Members of the Association: Gentlemen—As already announced, the Seventeenth Annual Meeting of the Association will be held at Baltimore, Md., on Wednesday, Thursday, and Friday, Oct. 16, 17, and 18. The headquarters of the Association will be at the Carrollton Hotel, which is conducted on the American plan. The meetings of the Association will be held in the Concert Hall of the Concordia Building, on German street near Eutaw.

As, in my circulars of July 29, I had considerable to say in the way of impressing upon members the necessity of procuring rooms in advance at the hotel, it is not necessary for me to say much on this point now. I would merely add, as a reminder, that the rate at the Carrollton is $3 per day, and if the members take the pains to write in advance for rooms they will all be taken care of.

I am assured by the Committee that the hall selected for the meetings of the convention is in all respects a desirable place. Certainly this is a good cause for rejoicing, because a suitable hall adds greatly to the pleasure of the meeting.

There is no change in the literary part of the programme, which is as follows:

"Fuel Gas," by Walton Clark.

"Gas Coals of the United States," by H. C. Adams.

"Care and Operation of Gasholders," by C. L. Rowland.

"Water Gas," by F. H. Shelton.

"Leakage and Condensation," by E. C. Jones.

"Purification of Gas from Kansas Coals," by B. E. Chollar.

"Conduct of the Electric Light Business in Connection with the Gas Industry," by W. H. Pearson.

"Advantages of Supplying a Mixture of Coal and Water Gas," by T. G. Lansden.

"Some Thoughts on Fuel Gas, Induced from Practical Experience in the Distribution of Natural Gas," by John Young.

No particular effort has been made to add to the number of papers during the last month, as it is thought that to thoroughly digest these dissertations will take up all the time of the meeting. I have the following conundrums for the Question-Box:

"Is it wise to make a special discount on gas used for cooking and heating?"

"Is the scheme of introducing air into gas for the purpose of reviving the iron a success?"

"What progress has been made this year in the matter of regenerative furnaces?"

If the members have any other questions for the box I would suggest that they be sent along as promptly as possible.

It is expected that the proper disposal of this programme in the allotted two days will be just sufficient tax on the energies of the members to make the relaxation of Thursday evening and Friday all the more enjoyable.

On the evening mentioned—the second of the meeting—the Association will be tendered a dinner by the Messrs. Bartlett, Hayward & Co. On Friday the Association will enjoy a sail down the beautiful bay, stopping at points of interest, and during the trip the members will be the guests of the Maryland Meter and Manufacturing Company. An inspection will also be made of the Chesapeake gas works, when we will be in the hands of the officers of the Consolidated Gas Company.

To the foregoing it is hardly necessary to add that the Baltimore meeting bids fair to be a profitable and enjoyable one. Each member should make strenuous effort to be present at the meeting.

I am now endeavoring to secure reduced railroad rates for the members attending the convention; a special circular on this subject will be issued to the members in a very few days. Those who are not now members of the Association and are intending to be present at the meeting should apply to the Secretary for a copy of the Transportation Circular.

Yours truly, C. J. R. HUMPHREYS.

BRIEFLY TOLD.

SECRETARY HUMPHREY'S SECOND CIRCULAR.—We presume that by this time Secretary Humphrey's second warning concerning the October meeting of the American Association has been carefully studied. We note with a satisfaction that the astute gentleman intimates that there is no likelihood of the paper list being increased over the proportions already assured. If—and there is no reasons for presuming otherwise—the contributors who have promised to regale their fellow-members with their experiences and knowledge on the various topics listed come to the mark with their essays, there is no doubt that the time will be fully, pleasurably and profitably occupied. Another very gratifying evidence of the interest that is being taken in the meeting is found in the fact that the question-box already contains three connundrums that ought to lead to a valuable discussion. It is, however, strange that query No. 1, should again figure as a factor; for we thought that it had become a well settled rule that the policy of granting a special rate on gas used for other purposes than that of illumination was in line with wisdom. Of course, in this as in other instances, no hard and fast rule can be drawn which will be applicable to all situations. Where gas is close to the dollar mark perhaps the consumer has a right to think that no concession should be made that did not apply to all alike—an opinion undoubtedly that would be shared in by the gas suppliers; but when we come to small places, where the rate for illuminating gas is high, and where its use for other purposes affords almost the only means for extending the business of the company, then we think the concession plan is not only justifiable but perfectly in accord with wisdom, equity and good business policy. However, we can depend upon it that this query will be thoroughly discussed at Baltimore, and that the man from Hartford will have something to say on the subject. We notice that our advance hints as to the outing-time to be enjoyed by the Association outlined truthfully that which the members might look forward to in the line of pleasuring. Furthermore, as it now appears, the entertainment programme is assuredly in keeping with what we may expect from the papers and the debates. It will also be noted that the Secretary is actively engaged in an attempt to secure favorable transportation rates, and as he usually accomplishes that which he sets out to perform, it may be taken for granted that the railroad magnates will make some concession. It is not altogether improbable that special arrangements will be made to convey in a body in special cars the party who will journey to Baltimore by way of New York.

SECRETARY HUMPHREYS informs us that he will mail the Association badges to members during the present week.

ON Sept. 3 the Lawrence (Mass.) Gas Company was granted the right to run mains, etc., in the town of North Andover, and 9,000 feet of 10-inch pipe will be laid at once.

A MEMPHIS (TENN.) PROPOSITION.—The following petition (which is now before the Memphis Council) foreshadows the beginning of the end:

Whereas, The Memphis Lighting and Power Companies, a corporation organized under the laws of Tennessee, and having its situs in Shelby county in that State, and which is hereinafter termed "The Companies," has petitioned the Legislative Council of the Taxing District of said county, a municipal corporation, successor to the old city of Memphis, Tenn., and which is hereinafter termed "the city," for the licenses, privileges and rights hereinafter set forth, to which the city, upon the considerations and conditions precedent and reserved below set forth, hereby assents. Therefore, this agreement witnesseth:

1. That the city hereby grants permission, and assents to and approves the acquisition by The Companies, by purchase, lease, or any other arrangement, of the properties, franchises, rights and privileges, and the shares of stock of other lighting and power companies now, or hereinafter doing such business within said city, and to use and operate the same so far as, by law, the city is authorized to so grant.

2. That the city hereby grants permission to The Companies to lay down such pipes, mains, conduits, etc., and erect such works, etc., as may be necessary for its business, under the streets and alleys of said district and upon The Company's private grounds, and through the same manufacture and conduct gas, etc., for furnishing light to the city and inhabitants thereof; no such pipe, main or conduit, however, at any time to be laid without first the city has approved plans and specifications thereof, defining the route or streets and alleys under which they may be laid, and the manner and kind thereof.

3. That for the purpose of looking after and protecting the interest of the city about the business contemplated by this agreement it may each year during the term of its continuance appoint one person who may be a member of the Legislative Council, or other person, as the city may from time to time select, and who shall be a director in fact, and be entitled to examine and inspect The Company's books, accounts and contracts, and subject to whose approval no purchase, lease or other acquisition of stocks in, or of properties, privileges and franchises of other persons or corporations may be made. Such representative of the city may report to the City Council from time to time all such matters of The Company's business as may be deemed advisable.

4. That the cost of lights furnished by The Companies shall never, during the term of this agreement, exceed the current rates at the date of the execution hereof, viz.: street lamps for the city, $16 per lamp per annum; individual consumers, $1.75 per thousand feet—and the rate charged the city shall be lessened 12½ per cent. each year below the rate paid during this current year, so as to secure to the city free gas at the end of the term of eight years from January 1, 1890. It being understood that the city may increase the number of its street lamps not exceeding one hundred (100) on an average per annum, and may require The Companies to extend its mains, pipes, conduits, etc., from time to time along such streets and alleys as the public interest may demand, and for public lighting.

5. That the capital of The Companies (stocks and bonds) shall not exceed the sum of $1,500,000, except on the consent of the city first had and obtained by resolution of its Council. And the net earnings of The Companies, after payment of all operating expenses and repairs, and of $17,500 a year fixed charges, and 5 per cent. dividend upon capital stock, shall be divided into equal parts, one of which is to be paid at the close of the fiscal year in which earned, into the treasury of the city, the other of which is at the same time distributable as further dividend among the shareholders of The Companies.

6. That The Companies shall, after payment of cost of its plant and works of every kind, as to all extensions of its lines and further works, keep a separate account of the cost thereof to be styled "common city stock account," which shall be summed up at the close of each year, and for the total of which further new stock may be issued by The Companies, one-half the amount thereof to be issued to the city, and the other half to the other stockholders in The Companies, the city to the extent of its half of such further stock issues being thereby a shareholder in The Companies; all this further new issue of stock to stand on same footing in every respect as and with every other shareholder in The Companies.

7. That The Companies agrees and binds itself to furnish to the city gas for its public lighting during the period of this agreement, inclusive of lighting the streets, parks, alleys, offices, engine houses and other public service, to the like extent as the city has heretofore and now requires such service, and which service the city may enlarge and extend from time to time as the public interest requires, but not more than one hundred (100) additional lamps per annum. Such street lamp lights to be of size so as to burn not less than five (5) feet of gas per hour.

8. That whenever the net earnings of The Companies, after payment of all expenses of operation and repair, said fixed charges and 5 per cent. dividend on its outstanding capital stock, leave a further fund or surplus in its treasury, the cost or price of gas to individual consumers may be reduced by the Council of the city so that The Companies' revenue shall not exceed $10,000 surplus in any year—nothing in this agreement, however, to prejudice the State's right, if any, of fixing the price of gas to be sold by The Companies.

9. That the gas supplied by The Companies shall be of twenty-five (25) candle power, as free from impurities and as non-prejudicial to health as that now or heretofore in use in said city, and entirely acceptable and approved by the health officers of the district. And The Companies agrees to construct, lay down or acquire such works, pipes, conduits, etc., of capacity to supply the city and its inhabitants with gas within the term of one year from the date of this agreement, and to maintain and operate the same for the term of twenty-five years. The works of The Companies for manufacturing, storing and reservoir, etc., purposes, shall be located only at such point as may be approved by the city, or if removed by same, to bear city taxes the same as if located in the city limits.

10. That all police powers and rights of the city as to the plant, works and business of The Companies is reserved and not granted away by anything in this agreement, and for the failure of The Companies to do or perform any one or more of the several undertakings and agreements herein specified to be done by it, at any one or more times, the city may at any time or times declare this agreement and all rights hereunder null and void and absolutely forfeited, and all right of appeal is waived.

11. And the city, in consideration of the benefits to be derived by it from the performance by The Companies of the several undertakings by it hereinbefore set forth, further undertakes that so far as it may be authorized to act in that respect it will not, during the term of this license, permit any other gas company, except natural gas, a right of way upon or under any of the streets or alleys of the city without first forfeiting this contract.

Unaccounted-for Gas.

By Mr. T. Frizelle.

[Read at the annual meeting of the North of Ireland Association of Gas Managers.]

When consenting to note down a few ideas on the above subject, I did so in the hope that they might lead to a quiet and profitable conversation among the members. I cannot say I have anything startling to state, or perhaps even new to the majority of my fellow members, for I presume we all have more or less unaccounted-for gas; but if every member of this Association should refuse to give his ideas or experience on the different subjects in connection with our industry, unless he had some new elaborate invention to explain, where would be the necessity of our meeting together from distant parts of the North, at, to some it may be, considerable inconvenience? I presume we are not all gifted with brilliant inventive genius; but we have all our difficulties to encounter and overcome, and a slight review of these difficulties and how we met them would, I am certain, be most interesting and instructive to the members generally. I, as a junior member, feel that some of our seniors should in this case lead the way, as it is certainly to be expected their large experience would be most beneficial and instructive.

There is a truism to the effect that gas profits are either made or lost in the retort house. Now this is true so far as it goes, for if profit is not made in the retort house it may not be looked for outside, yet the profit so made can be lost, and more, before the gas reaches its destination. To prevent this loss should be the earnest desire of every manager. In the first place, attention should be given to the station meter, to see that it registers correctly; for if the station meter is not correct, the calculation of loss cannot be estimated. If it registers slow, the leakage, etc., will follow all the same, besides the make per ton will also appear less. If it registers fast, the opposite will be the result; and at the end of the quarter, the leakage will be up accordingly. So then the station meter should be occasionally tested to see that it is telling the truth; and this can be done, if no better appliance is at hand, by shutting off the outlet valve at the back of the meter, tapping a 2-inch hole both above and below the valve, and connecting a large consumer's meter to it, so that the gas which passes through the station meter must also pass through the test meter before it reaches the gasholder. It is, of course, essentially necessary that the test meter should first be proved correct. Having proved the station meter to be correct, the next object of attention is the gasholder. I am convinced a greater quantity of gas is lost about gasholders than is given credit for—in one way by allowing the holder to fill too full and so blow off. Especially is this the case in works where the capacity of the gasholders is small when compared with the consumption. For instance, in the winter time, before mills and factories are lighted up, the holders are charged to their utmost; and if the evening remains clear longer than usual, or the temperature rises, the gas must escape into the air. Or perhaps a fog has been hanging overhead, and suddenly clears off when the retorts are in full work—though I must say we are not so subject to fog as some of our neighbors across the Channel. In the summer time also, by reason of the sun bursting out after cool weather, up rise the holders perhaps a sheet or more, and if almost full previously, the gas is bound to get away. And in many other ways gas may be lost; as by careless attendants allowing the valve to remain open too long before changing a holder, or perhaps opening the wrong valve. This is most liable to occur in small works where one or two men are called upon to perform several duties, and their attention is thus divided. Now these may all appear simple and frivolous little matters to most of the gentlemen present; but attention to these little matters is sure to bring its own reward. Every work requires its own attention, according as the necessity arises; and strictness on the manager's part often prevents careless waste by assistants. But the greater quantity of unaccounted-for gas is laid down as leakage and condensation through mains and service pipes, and very rightly so, especially if the mains have been improperly laid, or the joints and service pipes carelessly connected. Strict attention on the part of the manager or superintendent while main and service pipes are being laid is undoubtedly necessary, and doubly repays the attention given afterwards. I wish to point out one way especially in which a great number of gas companies err, and that is by employing so-called handy laborers, who may not be accustomed to the work, to lay mains and services. I repeat, it is false economy to employ men of this description to do some of the most particular work. Few men of the class can be depended upon in the absence of an overseer. There certainly are exceptions, but they are few; and it is to be expected that if men of the sort I have described make a blunder, they will have it covered over as soon as possible, so that it may not be discovered for a very long time, and that is another drain on the profits day and night perhaps for years. I consider great error is made in this respect. "The best workman is certainly the cheapest"—an experience which is sometimes dearly bought. But there is another cause for leaky mains, which the workman, no matter how clever he may be, or how much care he may exercise when laying, cannot prevent in the ordinary course, and that is when the ground subsides. Especially does this occur when mains are laid down in newly made, filled in, or reclaimed ground, even after years; and also generally where mains are laid along roads reclaimed from the sea. A case of this description came within my own notice some time ago, where 15 joints in succession of an 8-inch main were leaking. The lead in some of the joints was drawn over ½ inch, through which leakage was undoubtedly going on for some considerable time; but as the main ran just outside the works, the smell was usually put down as coming from there, and especially from the waste lime heap. To give an idea of the bottom on which this 8-inch main is laid, I may say that while a man stood in the trench to stave up the lead in the joint, he sank over the boots in mud; so in a case of this description, nothing is to be expected but drawn joints, leakage and other difficulties to follow. Constant attention, therefore, is required.

The manner in which I generally localize leakage in the mains is by driving down a sharp-pointed bar alongside the main pipe. In this manner I have tested over 2 miles of main in one direction in a few weeks; and detected and stopped 39 leaks, some of them very considerable, and strange to say, all were from faulty joints. In but one instance was the pipe broken; and this happened, I believe, by the root of a tree springing the pipe during a storm. No doubt the leaks from some of the points were small; but taken together they produced a very considerable and constant loss, and each of them lit above ground when a light was applied after tapping. There are other ways of detecting leakage from mains—one being by the use of patent syphons. They act as syphons or wells and leak detectors when required, and I am sure save a lot of trouble. And there are also gas leakage indicators which are supposed to show where a leak exists by simply carrying the indicator over the ground. I have not used any of these, as so far the pointed bar has answered my purpose. In passing, I may mention one leak which gave me some little trouble to find from what part of the main it was coming. I had no difficulty in finding the smell, nor in getting a light above ground (this invariably took place at a rise of ground). So I had the main stripped for yards; and thereby came upon an old built sewer, which had been unused for years. Out of this sewer the gas was coming. I therefore came to the conclusion that the gas was perhaps getting into the sewer at the foot of the hill or wherever the main crossed the sewer; and in this I was right. I found that the gas from two leaky joints made its way into the sewer, and was thereby conveyed to the higher level 150 feet distant. I consider it necessary that periodical testing should be made on any gas main, and too long a time should not be allowed to elapse between testing. The effect of excessive pressure on the gas in the mains is the cause of increased leakage; and when a proper supply cannot be maintained in any district without this pressure, the sooner a larger main is laid the better and more profitable it will be for the gas company.

Now, in regard to service pipes. Some authors have laid down ten years as the life of a malleable iron service pipe in the ground; holding that at the expiration of that time all service pipes should be renewed. That may be so where the soil has a peculiar oxidizing effect upon the iron; but generally the service pipe is kept in for 15 and sometimes 20 years, unless in case of alteration, or until it shows signs of leakage. Now this should certainly not be allowed, for leakage may be going on for years out of a service pipe before it is detected; and it is astonishing how soon some service pipes are honeycombed with rust unless they are specially protected—for instance, when they cross or run through a sewer, as is sometimes the case. I repeat, gas may be getting away for years in this manner without being detected. But I consider every district should be judged according to the nature of the soil and other considerations; and on the very first appearance of weakness a complete renewal should be effected. In some of the large English towns the services are laid in a wooden trough and covered over with boiling pitch, which should certainly protect them and repay the extra expense in laying. I find the service pipes to the public lamps another source of leakage, especially the tube in the pillar. I have renewed a large number which I found in a much worse state indeed than the pipe under ground; and I am of opinion the reason was, this tube is more exposed to the oxidizing effect of the atmosphere and rain trickling down from the top of the pillar. Another way in which gas is unaccounted for is by reason of the burners of public lamps passing more than the stipulated quantity; and this usually takes place where lamps are placed on a higher level without a governor or regulator being connected to them. But al-

together apart from the levels of different lamps, without a governor or regulator it is impossible to procure common burners which will pass the one quantity of gas, although numbered alike. There may be such, but I confess I have never met with them. Therefore it is the more necessary to have regulators on all public lamps, high or low, so that all may pass a like quantity.

In conclusion, I would say, strict attention should be paid to the meters. I think, in general, wet meters especially do not receive that attention which is necessary. I consider three months certainly too long a time for a wet meter to run without attention, especially in the lighting season. A great deal depends upon what a meter is called upon to do; and in regard to this, I would say it is false economy to place a 3 or 4-light meter to supply gas for 10 or 12 burners, apart from the unpleasantness caused to the consumer by the light popping out, it may be when his shop is full of customers, or when he is entertaining company and all available burners are lighted. This is one of the chief sources of prejudice which consumers generally have against wet meters. I am sure, apart from the discomfort to the consumer, this is another way in which gas is unaccounted for.

Now these little matters taken singly may not produce a great change in the leakage account. But there is an old Scotch saying: "Mony a mickle mak's a muckle;" and attention to all these little matters is so much money saved, and at the end of the year the result would no doubt show for itself.

Discussion.

Mr. Stormonth said the Association were indebted to Mr. Frizelle for the very comprehensive view of the leakage question which he had given them in his able paper. It was a subject of the greatest importance, and any information which would assist them in their endeavor to keep the leakage at a minimum would be warmly received. He agreed with Mr. Frizelle that the best labor was the cheapest in the long run; and in his opinion it was a great mistake to employ that useless machine, the handy man. He had had experience in that way, and that was his opinion. There was one point upon which he would like a little information, and that was as to the saving which Mr. Frizelle made. It should be very considerable, and he hoped that Mr. Frizelle would be able to give them this interesting piece of information.

Mr. Whimster said he was compelled to get up and say a word in defence of the "handy man," who had just been the recipient of so much abuse. He objected to the epithet of a "useless machine," as applied to him; and he was of opinion that a good handy man was better for laying mains and services than a mere tradesman. Perhaps he might be slow, but he was sure; and the work was well done in the end.

Mr. Stormonth said that there were exceptions to every rule.

Mr. Robb (Cinderford) said he was laying mains at present, and the work was well done by a man whom he had himself taught. The manner in which he did his work gave every possible satisfaction.

The President said that he also had a very good man. His leakage at one time amounted to about 40 per cent.; but he had now been able to reduce it very considerably. He sent a man smelling at the tops of the lamps, and found that there was a very considerable escape in that way, as the lamp post formed a sort of funnel or chimney through which the gas escaped. He had now managed to get the leakage down as low as 5 per cent.

Mr. Robb—That is exactly my leakage.

The President—Yes; but you did not commence with about 40 per cent.

Mr. Frizelle said that with regard to the "handy man," there were, of course, exceptions to the rule; but generally he adhered to the opinion he had expressed. He found that if they made a mistake they would cover it over and say nothing about it—with the result that very often leakage went on for years undiscovered. He was merely speaking of the handy laborer as he found him. With reference to the question of saving, he wished to say that last year he made 670,000 cubic feet more gas than in the previous year, and he carbonized last year 38 tons less coal than in 1888. He thought this proved very conclusively that the question of leakage was a highly important one and should be looked to.

Mr. Williamson asked Mr. Frizelle if there was any change in the quality of the coal.

Mr. Frizelle—No; we used the same coal from the very same coal merchant.

LATE reports from Macon, Ga., are to the effect that Mr. B. Van Steenbergh, President of the Macon Gas and Water Company, has received a proposition from certain English capitalists for the purchase by them of that property. It is too bad that Mr. Boardman parted with control of this enterprise.

Stewart's Gas Making Apparatus.

U. S. Letters Patent, No. 409,761, were granted on Aug. 27 to W. T. Stewart (who subsequently assigned a three-quarter interest in the same to Mr. W. H. Denniston, of Pittsburgh, Pa.) of Pittsburgh, for an apparatus for the manufacture of gas.

In the drawings, Fig. 1 is a front elevation of the apparatus; Fig. 2 is a vertical section of same on the line II. II. of Fig. 3; Fig. 3 is a vertical (irregular) section on the line III. III. of Fig. 1; and Fig. 4 is a horizontal (irregular) section on the line IV. IV. of Fig. 2. In the drawings the setting or walls of the apparatus are shown at 2; 3 is the chamber containing the retorts or generators, and 4 is the combustion chamber.

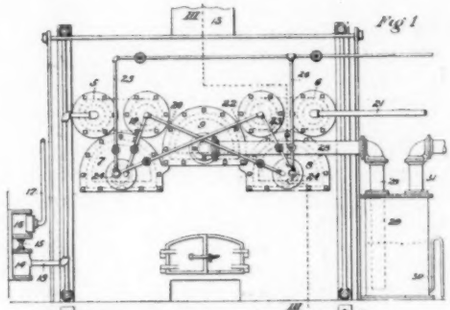


Fig 1

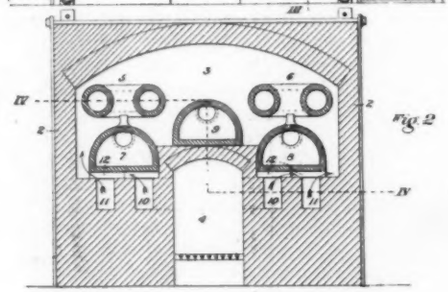


Fig 2

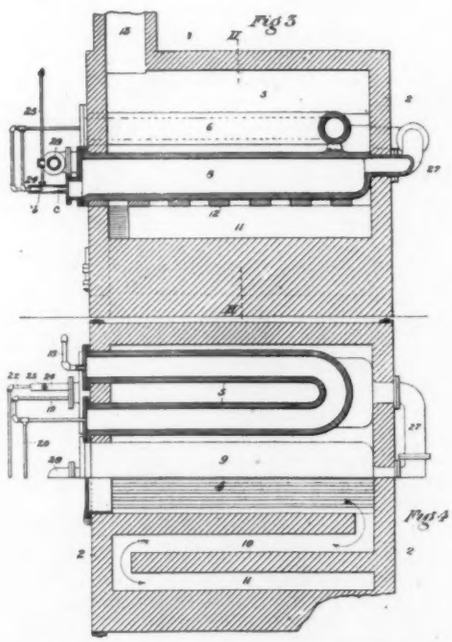


Fig 3

Fig 4

The chamber 3 contains the following retorts or sub-chambers: A pair of chambers 5 6, each of which is made, preferably, of U-form, extending from the front wall of the chamber 3 to or nearly to the back wall; a pair of retorts 7 8, each of which is arranged beneath one of the retorts 5 6; and a retort 9, which is preferably situated at the middle of the chamber 3, above the combustion chamber 4. The retorts 7 and 8 are preferably made of cast iron, open at their front ends, and are provided with removable caps or cover plates *b*, which are secured to the open ends by bolts *c*. The arrangement of flues leading from the combustion chamber 4 into the chamber 3 is as follows: At each side of the

combustion chamber are flues 10 11, both of which sets of flues are shown in Fig. 2, and one of which is shown in Fig. 4. The flues 10 communicate with the combustion chamber at the rear end thereof, and extend horizontally parallel therewith, and the flues 11 connect with the flues 10 at the front ends thereof. The flues 10 and 11 underlie the retorts 7 and 8, and are separated therefrom by tiles 12, which thus form parts of the floor of the chamber 3, and which are separated so as to leave interstitial spaces, through which the heated products of combustion in the flues 10 and 11 have direct access to the floors of the retorts 7 and 8. The flame and products of combustion from the combustion chamber 4 pass through the flues 10 and 11, and in their passage through the flues 11 escape upward through the interstices of the tiles 12 into the chamber 3, through which they circulate, and from which they finally emerge through the stack 13, thus heating all the retorts or sub-chambers in a most thorough manner.

The manner in which the retorts are supplied with the elements from which the gas is made is as follows: 14 is the air cylinder of an air pump, the piston rod 15 of which is operated by a steam engine 16, which derives its steam from a supply pipe 17. The delivery pipe 18 of the air pump 14 leads into the end of one of the branches of the curved retort 5, and from the end of the other branch thereof pipes 19 and 20 lead to the front ends of the retorts 7 and 8 respectively.

21 is a steam supply pipe which enters the end of one branch of the retort 6, and 22 and 23 are pipes which lead from the end of the other branch thereof to the front ends of the retorts 7 and 8, where they terminate in injectors or siphon-nozzles 24, one of which is shown in Fig. 3. These injectors are provided with tapering nozzles *b*, which communicate directly with the steam supply pipe and with a larger tapering nozzle *c* in advance thereof, into which enters a pipe which supplies hydrocarbon liquid, preferably crude petroleum. These oil supply pipes are shown in Figs. 1 and 3, where they are designated by the reference figures 25 and 26. Each of the retorts 7 and 8 communicates with the rear end of the retort 9 by a branch connection or pipe 27, Figs. 3 and 4. From the front end of the retort 9 a delivery pipe 28 leads directly to the furnace or other place of use of the gas, or indirectly through a washer 29, which may be partially filled with water and provided with the usual overflow pipe 30. From thence the gas is taken through a pipe 31, either to holders or scrubbers and purifiers, or to suitable furnaces.

In using the apparatus a fire is kindled in the combustion chamber 4, so as to heat up the chamber 3 and the several retorts which are situate therein. When these have been raised to a high heat the air pump 14 is started into action, steam is caused to pass through the pipe 21, and oil is passed through the pipes 25 and 26. The air passes through the double retort 5, becoming highly heated in its passage, and thence through the pipes 19 and 20 enters the retorts 7 and 8. In like manner the steam is superheated by passing through the double retort 6, and is discharged into the injectors 24 from the nozzles *b*, in which it induces a supply of oil from the pipes 25 and 26, and the steam and oil spray enter the retorts 7 and 8, where they mingle with the air from the pipes 19 and 20 and are heated, and the air and steam, being preheated before their admission into these retorts, unite with the oil to form a gas. From the retorts 7 and 8 the gases pass into the retort 9, where they are further heated and fixed, and from the retort 9 they pass through the pipe 28, as before explained.

There is a certain quantity of the less volatile constituents of the crude oil which will deposit in a liquid form in the retorts 7 and 8, and unless some means were afforded for converting this into gas it would not only be wasted, but would clog up the retorts so as to impede the working of the apparatus. The pressure of the incoming air and gas in the retorts 7 and 8 is, however, sufficient to carry this residuum up through the branch pipes 27 into the secondary retort 9, where the heat to which it is subjected causes it to unite with the air and steam to form a gas. In this manner the inventor claims to utilize all the oil introduced into the apparatus.

The gas produced may be used either for illuminating purposes or as fuel gas. When it is desired to produce fuel gas, the inventor prefers to supply the air and steam to the apparatus at a greater pressure than when illuminating gas is to be produced, and he claims that very good results are produced by supplying the air at about 8 pounds and the steam at about 20 pounds pressure to the square inch for making illuminating gas, and the air at about 10 pounds and the steam at about 60 pounds pressure for making fuel gas.

His claims are:

1. In apparatus for the manufacture of gas, the combination, with a furnace or oven and with each other, of a series of five retorts, two of the series being U-shaped superheaters, two of the series gasifying retorts, and one a fixing retort, one of the said U-retorts or superheaters being connected directly with each of the gasifying retorts, and the other of said U-retorts or superheaters being connected with each of the gasifying retorts by means of intermediate oil injectors, and each of the gasifying retorts being connected with the fixing retort.

2. The combination, with an oven having a central fire chamber and reflex flues parallel therewith, of two gasifying retorts, a series of spaced tiles for supporting said retorts above the parallel flues which connect the fire chamber and oven, and a fixing retort arranged between the gasifying retorts and over the fire chamber.

3. The combination, with an oven, a central fire chamber therefor, and parallel reflex flues which connect the fire chamber and oven, of two gasifying retorts located over the reflex flues of the fire chamber, a fixing retort located intermediate of the gasifying retorts and over the central fire chamber, and superheaters located within the oven and over the gasifying retorts.

4. The combination, with a furnace and oven communicating with each other by parallel reflex flues, of two U-shaped superheating retorts, two gasifying retorts, and a fixing retort, one end of one of the U-shaped retorts being connected with an air pump and the other end with each of the gasifying retorts by pipes 19 and 20, and the other U-shaped retort connected at one end with a steam supply, and at the other end with each of the gasifying retorts, by means of pipes 22 and 23 and intermediate oil injectors 24, and each of the gasifying retorts communicating with the fixing retorts by pipes 27.

5. The combination, with an oven having a central fire chamber and reflex flues parallel therewith, of two U-shaped superheating retorts, two gasifying retorts located on opposite sides of the fire chamber above the reflex flues, and a fixing retort arranged over the fire chamber, one of said superheaters connected at one end with an air supply and at the other end with each of the gasifying retorts by valved pipes 19 and 20, the other superheater connected at one end with a steam supply and at its other end with each of the gasifying retorts by valved pipes 22 and 23 and intermediate oil injector 24, and each of the gasifying retorts communicating with the fixing retort by pipes 27.

Compressibility of the Gases Oxygen, Hydrogen, Nitrogen and Air up to the Pressure of 3,000 Atmospheres.

[By E. H. Amgat, in *Comptes Rendus*, and translated by Chief-Engineer Isherwood, U.S.N., for *Journal of Franklin Institute.*]

The experiments on these gases were made according to the method I followed in my previous investigations of the compressibility of liquids within the same limits of pressure: but, in the present case, the difficulty was much greater, owing to the smallness of the volume of the gases when strongly compressed. Nevertheless, after numerous trials, I obtained perfectly regular and concordant results by employing, for the gauging of the platinum wire tubes, the same process of reading by electrical contacts which served afterward to estimate in the same tubes the successive volumes of the compressed gases. In this manner I obtained for the same gas, with different tubes, graphic curves which almost absolutely coincided with each other.

My results, given further on (and they are solely the apparent results), differ notably numerically from those obtained by Natterer. The differences within the limits common to our researches are very irregularly distributed, and amount to several hundreds of atmospheres. My experiments for the same reduction of the volume of the gas give in general much greater pressures than his, but the differences can easily be accounted for by the probable and even inevitable causes of error in the method followed by him.

The following results relate solely to great pressures; the pressures below 1,000 atmospheres will be investigated in part by means of an apparatus permitting the use of temperatures vastly higher than I have been able to command with the apparatus imposed by the very great pressures, and with which I have been able to operate between only 0° C. and 50° C.

The following table gives for the pressures, in the first column, the volumes of the gaseous mass at 15° C. relatively to its volume as unity at the same temperature and under the pressure of one atmosphere:

Pressure in Atmospheres.	Air.	Nitrogen.	Oxygen.	Hydrogen.
750	0.002200	0.002262	.....	.....
1,000	0.001974	0.002032	0.001735	0.001688
1,500	0.001709	0.001763	0.001492	0.001344
2,000	0.001566	0.001613	0.001373	0.001161
2,500	0.001469	0.001515	0.001294	0.001047
3,000	0.001401	0.001456	0.001235	0.000964

The comparison of the compressibility of strongly compressed gases with each other, and with that of the liquids, is interesting, and to facilitate it I have calculated for differences of 500 atmospheres of pressure the coefficients of compressibility of the gases, as habitually defined for liquids. In the following table are the results obtained:

Pressures in Atmospheres.	Air.	Nitrogen.	Oxygen.	Hydrogen.
Between 750 and 1,000 ...	0.000411	0.000407	.....	.....
Between 1,000 and 1,500..	0.000268	0.000265	0.000258	0.000408
Between 1,500 and 2,000..	0.000167	0.000170	0.000160	0.000272
Between 2,000 and 2,500..	0.000123	0.000122	0.000115	0.000197
Between 2,500 and 3,000..	0.000093	0.000091	0.000091	0.000158

We see that, under very great pressures, the gases oxygen, nitrogen, and air have nearly the same compressibility; and that it is of the order of magnitude of the compressibility of the liquids; at 3,000 atmospheres it is sensibly equal to that of alcohol under normal pressure.

The compressibility of hydrogen is very much greater—nearly double—and at 3,000 atmospheres it is almost equal to that of ether under normal pressure.

There may be easily foreseen that these compressibilities should, as in the case of the liquids, increase with the temperature, which is shown, as regards hydrogen, by the following table:

Limits of Pressure in Atmospheres.	Coefficients. At Zero.	At 15.4 deg.	At 47 3 deg.
Between 1,000 and 1,500.....	0.000	0.000408	0.000416
Between 1,500 and 2,000.....	0.000263	0.000272	0.000280
Between 2,000 and 2,500.....	0.000196	0.000197	0.000208
Between 2,500 and 3,000.....	0.000156	0.000158	0.000158

The apparent densities are easily deduced from the first table; and admitting, provisionally, for the compressibility of glass the number generally adopted, we obtain the following results for the pressure of 3,000 atmospheres:

Densities of the Gases under the Pressure of 3,000 *Atmospheres, Relatively to Water.*

	Apparent.	Real.
Oxygen	1.0972	1.1054
Air.....	0.8752	0.8817
Nitrogen	0.8231	0.8293
Hydrogen	0.0880	0.8887

The curves obtained by laying off the pressures as abscissas on an axis, and the products $p\,v$ as corresponding ordinates perpendicular to the axis, are nearly straight lines, but they all have a slight concavity toward the axis. I shall return to this important point as regards the limited volumes after I shall have determined the variation of the volume of the envelopes.

Steam Plants for Electrical Service.

[A paper read by Mr. W. H. Bryan, at a meeting of the Engineer's Club, St. Louis.]

Few industries of modern years have shown the wonderful growth that has characterized the manufacture and use of the various forms of dynamo-electric machinery. Less than ten years ago the arc electric light was just becoming known, and the incandescent lamp was scarcely more than a curiosity, while the electrical transmission of power was hardly thought of. To-day there are few towns of 3,000 inhabitants but boast their arc or incandescent electric lighting plants, and many smaller places are fully as progressive. In the large towns and cities the great business houses have their own plants, and central stations whose capacities are measured by the thousands of horse power are not uncommon. Add to these the electric railway, which has now demonstrated its success, and we get an idea of the vast possibilities of this field of energy which is still in its infancy. While many of the earlier stations did not prove as successful financially as was anticipated, the test of continuous and regular service has pointed out the weak places, and they have been remedied. When careful business sagacity and caution are exercised—as they must be in any successful venture—the electrica industries to-day offer excellent returns to the capitalist. Perhaps the best evidence of this lies in the gross capacity of plants now in operation, estimated at 750,000-horse power, and fast nearing 1,000,000.

The world waits impatiently for that immortal inventor whose genius shall show us how to produce electricity direct from coal. We must take things as we find them, however. Our boilers and furnaces give back in steam less than 80 per cent. of the energy of the coal burned. This steam does work in a woefully imperfect engine, utilizing less than 15 per cent. of the heat units. This engine, in turn, drives the dynamos by which the electric current is generated. After distribution the current reappears in the form of the electric light—there being a further loss of, say, 10 per cent. in each of the last steps. It is evident, therefore, that in the best plants less than 10 per cent. of the energy in the coal consumed is reproduced in the form of light. The poor plants, which are far more common, do not reach 5 per cent.

And yet within these appallingly low figures there is abundant room for study. The conversion of fuel into electric energy has caused the development of steam plants adapted specially for this service. The business of these stations is, in fact, the selling of power, and the steam plant is therefore of prime importance. It is not too much to say that permanent commercial success is conditional, first of all, upon a properly designed steam plant. Many companies have found, to their sorrow, that a cheap outfit has proved wonderfully costly to operate and maintain. Others have shown that a somewhat higher first cost has been fully justified by reduced expense of operation and greater reliability. The furnishing of electric light and power may now be regarded as a permanent industry, and the installation of plants presents a broad field of usefulness to the engineer.

Too often the selection of the motive power is left to someone wholly inexperienced, who bases his conclusions upon considerations which are far from being the ones of first importance. The results are as might be expected. We see on every hand instances of mistakes which are costing thousands of dollars unnecessarily in fuel bills, repairs, power wasted, etc. Machinery is now built capable of maintaining one-horse power one hour on 1½ pounds of good coal. When we remember that in most plants 5 to 6 pounds are required, and instances are not uncommon where it reaches 10 and even 15, we see that great improvements are possible. The wonder is, not that electric lighting has sometimes proved unremunerative, but that it has ever paid under such conditions. The inevitable conclusion is that the fierce competition which now exists, and which bids fair to continue, will result in the "survival of the fittest" only. That electrical station which builds its steam plant in strict accordance with the best principles of modern engineering, has already won more than half the battle, and will surely distance the one in which those principles are considered of minor importance.

Some furthur explanation of the percentages given above may not be out of place. A boiler efficiency of 80 per cent. is the best attainable under ordinary working conditions. The purposes of combustion necessitate a good draft. This is proportional to the difference in temperature between the chimney gases and the outside air. It is, therefore, necessary to discharge the gases at a temperature considerably above that of the steam in the boiler.

Nor is the case of the engine as bad as appears at first sight. Its efficiency also is limited by the range of working temperatures. The higher the initial temperature of the steam, and the colder it is when finally discharged, the higher will be the efficiency. This is best shown by the well known formula—

$$E = \frac{T_1 - T_2}{T_1},$$

where T_1 is the initial and T_2 the final temperature of the steam, both measured from the absolute zero.

Practical conditions, however, confine us to narrow limits. High initial temperatures mean greater pressures, more costly plant, increased liability to accident, and difficulty of maintenance and repairs. The lowest temperatures which can be reached in practice are far above the absolute zero. These losses are inherent in the theory of the steam engine, and but little increase of efficiency is possible. As a matter of fact, the engine which can furnish one horse power with 13 pounds of water evaporated per hour, is very close to the highest that is possible under the best conditions of modern practice.

Economy of fuel, however, is not always the most important consideration. Conditions frequently arise which render a sacrifice of fuel necessary to secure other and more desirable ends. The work required of an electrical station differs in important respects from other plants in public service. Gas and water works have their storage reservoirs, enabling their work to be done under conditions favorable to high economy. Electrical plants, however, must supply the current directly as needed. Every increase or decrease in the number or candle power of the lamps burning must be instantaneously met by a corresponding change at the dynamos and steam plant. This state of affairs must continue until some of the many storage batteries now being exploited are shown o be sufficiently efficient, durable and cheap to justify their general adoption. Until then, those plants which do commercial lighting must necessarily, at times of greatest output, be forced to their utmost capacity, and at other time do little or nothing. Under such conditions economy of steam is out of the question. The *real* efficiency must be measured from the plant as a whole, and is a problem of considerable complication. To ascertain the actual cost per lamp hour, the

items of fuel, salaries, oil, and other supplies, lamps or carbons, interest, depreciation, repairs, losses due to poor service, interruptions, etc., must be given due weight. In the designing of a new station, it is of even greater importance to give each element of cost its proper consideration. No general rules can be laid down for guidance in studying a problem as complicated as this one. Some of the more important factors may, however, be mentioned.

Whatever the general design of the plant, whether arc or incandescent lighting or power, whether high or low tension, large or small, whether fuel is high or cheap, space costly or not, the one condition to which all others are secondary, is complete reliability under severe and continuous service. The public has a right to demand, and does demand, that the lights be always ready, and maintained to their full candle power. An interruption means, not only a loss which cannot be regained, but an injury to the the standing and record of the enterprise which months of steady running cannot counteract. Reliability can be secured by using only the best of machinery, as simple in construction as possible, cared for by good men. The plant should be divided into such units that in case of accident to any part of it that part may be thrown out of service, and the work assumed by the remaining apparatus, without straining the machinery or interrupting the output. This means a reserve sufficiently large to carry the work of any unit of the plant.

The particular electric system in use is the consideration of next importance. The cost of conductors, space required, closeness of regulation necessary, capacity and number of dynamos, all affect the steam plant. Low tension systems require costly conductors, and must be located close to the center of maximum lighting. Ground is here very valuable, and the most important requirement is to get the plant into the least number of cubic feet. High-duty engines occupy too much space, and water for condensing is usually not available. On the other hand, high-tension systems are less affected by distance, and should be located where land is cheap, and, if possible, where cars loaded with fuel can be switched alongside the boilers, and where an abundance of water may be had for condensers, or best of all, where water power is available.

The cost of the ground occupied, therefore, affects the arrangement of the plant and type of machinery.

The cost of fuel, as compared with its heat value, is of scarcely less importance than the system itself. If fuel is cheap, costly and complicated machinery to economize it is not justified. If high, it should be adopted as far as other conditions will permit.

The cost and quality of the water supply are important in selecting the type of boiler, heater, etc., and in deciding the question of condensers.

The distribution of a load through the hours of the night is worthy of careful consideration. High fuel economy is attainable only under certain fixed and favorable conditions. Among these the most important is the point of cut-off in the engine at which its efficiency is a maximum. The best authorities place this at between ¼ and ½ for single cylinder engines, working with initial pressures of from 80 to 100 pounds above the atmosphere. Both earlier and later cut-offs mean more fuel per horse power. In the latter case we exhaust the steam at too high pressure, and in the former the cylinder condensation increases so rapidly as to nullify gains from higher expansion. It does not pay, therefore, to use large engines when the load is at times small. The units of power should be so selected as to enable the engines to be run close to the point of cut-off of maximum efficiency. As the load changes, engines may be started or shut down, so that at most only one small engine is worked at a disadvantage. Having selected the size of engine best adapted for the work, there are advantages in the way of simplifying the attendance, care, repairs and general arrangement, by reduplication of parts throughout the plant.

Other conditions, which, while of minor importance, must not be lost sight of, are: The nature of the plant, whether permanent or temporary; the amount of capital available, which, however promising the returns, cannot always be secured to carry out plans in the best manner; and provision for growth. This latter is too frequently overlooked. No industry is capable of greater expansion by means of good service and reasonable charges. It often happens that after only short service the demand becomes such as to require extensive enlargements. If this necessitates the remodeling of the entire station it can only be done at greatly increased expense, and sometimes with serious interruption to the service.

All the large steam plants in this country are arranged on one of two general plans, which differ in essential characteristics. One school advocates the use of large slow-speed engines, belted to counter shafts, which run at increased speeds, and on which are placed friction-clutch pulleys and clutches, enabling any dynamo or engine to be thrown in or out of service at any time. To get the full benefit of this system the engines must be large and few in number. In practice two engines are generally used, belted to opposite ends of the counter shaft. The other school prefers smaller, independent engines, of the high-speed type, belted direct to the dynamos. Each plan has its warm advocates, and arguments are not lacking on either side. Which of these plans to adopt is the question which confronts us at the outset. The answer in any given case involves a careful study of the points I have discussed, and presents a problem of no small magnitude.

Two important advantages are claimed for the system using large slow-speed engines. First, the long stroke engine, with four independent valves, represents the highest known steam efficiency and requires smaller boiler plant and less outlay for fuel. Second, the use of shafting and clutch pulleys admits of the greatest interchangeability. Any dynamo can be run from any engine, and a dynamo or engine can be thrown in or out of service without affecting the rest of the plant.

On the other hand, the advocates of direct connected engines claim, 1st., That no power is lost in driving shafting; 2nd, That as stations are actually run under widely varying loads, the small engines can be operated at or near their best point of cut off, and will, therefore, do the work at less cost per lamp hour; 3d, That one or two dynamos to an engine offer all necessary interchangeability; 4th, That one small engine affords ample reserve; 5th, That electrical conditions demand close regulation of speed, from stroke to stroke, and under changing load and steam pressure, and that experience has shown that this is best secured by high speed engines; 6th, That a short circuit in a dynamo would slow down a small engine, thus giving warning of danger, while a larger engine would pull it through, regardless of results; 7th, That the plant occupies the least space; and last, but by no means least, the first cost, including erection and foundations, is less than for low-speed engines with shafting, etc.

That there is wide difference of opinion among prominent engineers on this question is shown by the fact that there are now being erected stations costing hundreds of thousands of dollars on both principles. Let us examine the claims made in the light of the requirements already laid down.

First as to reliability. Both plans claim simplicity of construction, but in my opinion "honors are easy." Two engines are, of course, easier cared for than a dozen, but as each of the large engines is not only much heavier than one of the smaller ones, but is more complicated in its valve gear, and the plant is further encumbered by the shafting, with its necessary bearings, couplings and clutch pulleys, we see no difference in the two. The large countershaft is a source of weakness, however; an accident to it means a suspension of the whole plant. The service required of it is severe, and it is not always easy to preserve the alignment. When out of line it consumes great power, and is a source of constant worry and danger. An accident to one of the large engines means a serious loss of capacity, while it is insignificant if the engines are small. In the latter case a reserve engine means a much smaller investment of idle capital and space. It appears, therefore, that independent engines are preferable on the score of reliability.

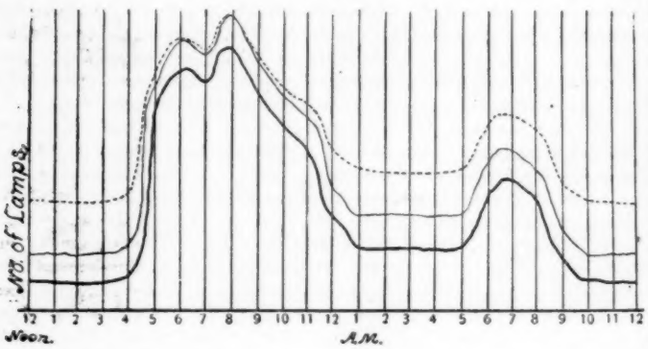
Second, as to the electrical system. If the plant can be located where there is abundant space, it may be planned with a view to the highest efficiency. If other conditions permit, all the advantages of high expansion and condensing engines may be utilized. On the other hand, if ground is valuable the use of direct belted high-speed engines is necessary. In those systems requiring close regulation of speed, they are also preferable, although slow-speed engines are being greatly improved in this respect by new designs, better workmanship, and the use of heavier fly wheels.

Third, as to their fuel economy. It is here that advocates of long-stroke machinery make their strongest claims. I have been unable to secure exact and reliable data as to the water consumption of the two types of engines per horse power per hour. From the best information I can get, however, I am inclined to place the water consumption of the low speed about 20 per cent. less than the high speed under similar average working conditions. Where fuel is expensive, and where the other limiting conditions mentioned above do not prevent, the low-speed engine should therefore be adopted.

There are, however, two important points which must be considered in this connection. The useful power delivered to the dynamos is always less than that exerted by the engine, by the amount of the friction of the engine and power-transmitting devices. In direct connected engines this loss is from 7 to 10 per cent. of the total, while with the shafting system it is usually from 20 to 25 per cent., and if the shaft is out of

line, may be much more. It thus appears, therefore, that a large part of the superior economy of the low-speed engine is off-set by the increased friction loss.

The economy is further affected by the amount and hours of loading. If the work done is large and constant, as is the case with plants operating contracts for city lighting, the low-speed engine has still a good balance in its favor on the score of fuel economy. If, however, the load is subject to wide fluctuations, as it is with commercial lighting—especially incandescent plants—the case may be different. The *real* efficiency cannot be measured under the best conditions, but for a whole day's run. The accompanying sketch may be taken as typical of



the work of all incandescent plants doing commercial lighting. The lower curve represents the net output of the dynamos measured in lamps burning; the next line shows the additional work done in friction, which is constant for all loads. It will be noticed that a single large engine doing this work must, for three-fourths of the time, cut off at times decidedly unfavorable to its economy. That is to say, that the steam required to operate the engine under the conditions would, if used in an engine cutting off nearer its point of maximum efficiency, do a great deal more work. The upper line represents the work which the steam consumed is capable of doing, if properly used. You will, no doubt, be struck by the amount of steam used wastefully as shown by the irregular space between the upper and lower curves.

By dividing the work among several smaller engines, which can be shut down and started up as required, but one engine, at most, works at a disadvantage. The friction loss is also less, and when each engine shuts down its proportional amount of friction ceases. It is evident, therefore, that independent engines have a decided advantage in net economy under variable loads.

I had intended to submit sketches of plant of say 1,000-horse power arranged in both ways, making a calculation of the efficiency of each, under variable loads. On investigation, however, I found that the ground had already been covered in an able paper by W. L. Church, read before the National Electric Light Association, at its meeting at Pittsburgh in February, 1888. Mr. Church presents data from two actual stations in which the ratio of fuel per lamp hour is as 70 to 126, in favor of independent engines.

Summing up, it appears that long-stroke engines are to be preferred where the load is approximately constant, provided sufficient space can be had, and provision is made for reserve. But for variable loads, and where space is valuable, as well as for greater reliability and closer regulation, the use of high speed engines appears to offer most advantages. The most prominent promoters of incandescent lighting in this country have adopted direct connected engines for their central stations.

A brief discussion of the integral parts of a steam plant for electrical service may be of interest.

The engine we have already considered at some length. The advantages of compound, triple expansion and condensing engines, are well known, and these principles may be applied with benefit to both low and high speed types. It must not be forgotten, however, that their recognized fuel economy is secured by greater complication of parts. A higher degree of skill is, therefore, required to operate them, and the liability to accident and derangement is increased. The full benefit of these principles can only be obtained where the load is large and approximately constant. It is evident, therefore, that these high types of engines cannot always be used with benefit. The success of stations now being equipped with high pressure boilers, and triple expansion condensing engines, will be watched with interest.

All sorts of boilers have been used, from the long cylinder, where fuel is cheap, or the water bad, to the water tubular. Each has its advantages. The horizontal tubular boiler is a quick steamer, occupies little room, is not high priced, and is fairly efficient. Among these, my own preference is for the boiler with four inch tubes, as it seems a happy mean between the flue boiler and the multitubular. The water-tube boiler is being widely adopted in electrical plants. Its advantages are: High efficiency; small space occupied; capacity for overwork; quick steaming, and safety. The type of boiler to be selected is usually determined by the quality and price of fuel, the space available, and the scale-making properties of the feed-water—although it is claimed the latter has now been eliminated by the invention of purifiers guaranteed to keep boilers free from scale.

The design of furnace and grate is also determined by the fuel. The furnace is modified by the question of whether *capacity* or *fuel economy* is of more importance. Rocking grates and mechanical stokers have points of value, but cannot be used successfully with all fuels. The use of petroleum as a fuel is increasing, as was shown by the interest in the subject at a recent meeting of the National Electric Light Association at Chicago. Comparing Illinois coal, a pound of which evaporates six pounds of water, and which costs 8 cents per bushel in St. Louis, with petroleum having an evaporative efficiency of 16 to 1, the oil must be furnished at less than 2 cents per gallon to make the fuel cost of evaporating 1,000 pounds of water the same in both cases. When we consider the greatly reduced cost of handling petroleum, and the exactness with which it can be regulated and controlled, and the fact that it is smokeless, it seems destined to wide adoption.

A handsome brick stack seems to me a desirable feature of any plant. Its solidity, strength, beauty, efficiency and absence of repair bills are worthy of consideration.

I have found the following formula useful in stack calculations:

$$a = \frac{100\,w}{d\sqrt{2\,g\,H\,\frac{D-d}{D}}}$$

in which H = height of stack in feet; a = area of stack is square feet; w = pounds fuel to be burned per second; D = weight of one cubic foot of air; d = weight of one cubic foot of chimney gases; $g = 32.2$ the acceleration due to gravity. If the outside temperature be 100° F., and the inside 450° F., the formula becomes:

$$a = \frac{460\,w}{\sqrt{H}}, \text{ or } H = \frac{211{,}600\,w^2}{a^2}$$

In non-condensing plants the exhaust steam should always be used for heating the feed-water. The quality of the latter is the determining factor in selecting a heater. There should be ample settling capacity, and the water should be outside of the tubes, which should be of brass or copper. There should always be a relief valve on the feed pipe near the heater, so that over-pressure cannot injure the tubes. If the water is very bad, it should be further purified by live steam. Heaters and purifiers should be so arranged that they can be frequently blown off, and also examined and cleaned without interrupting the service of any part of the plant.

For boiler feeding I prefer a direct acting, single pump, brass fitted. It should pump cold water through the closed heater, and if the water is gritty, should have outside-packed plungers. The boiler feeding apparatus is perhaps the most sensitive part of the plant. Instead, however, of providing two pumps and heaters, a first-class injector can be used. It is not only perfectly reliable, but ties up very little capital, occupies little space, and can, when called upon, take the place of either the pump or heater, or both.

The pipe system connecting boilers, engines, heaters, pumps, etc., is worthy of careful study. The points to be borne in mind are: Abundance of area, as direct lines and as few bends as possible; suitable provision for expansion and contraction, and drains. By means of return traps all condensation in the live steam pipes can be returned to the boiler. These pipes should be well protected by non-conducting material.

Belting is also of great importance. Its slip must be a minimum. It must be well made and of good material, to be durable and reliable at speeds of a mile a minute or more. I have here a sample of a leather link belt which is proving popular. It is so heavy and pliable that its arc of contact on the pulley is much greater than with ordinary belting. It can, therefore, be run very slack, thus avoiding the great strain on engine and dynamo journals which is usually required to prevent belt slip. It also prevents air cushion. The driving and driven pulleys can be brought very close together. Transmission of power by ropes instead of belts is now being tried, and has some advantages. They are very cheap and easily replaced. The ropes run in V-shaped grooves, which render slip impossible. Sometimes a single rope is used, which encircles

the pulleys a number of times, and is kept tight by passing over an idler, in the same manner as street railway cables. This arrangement is open to the serious objection that an accident to the rope means a shut down.

This could be obviated by dividing the rope into a number of parts, each independent of the other. The number should be sufficiently large that in case of accident to one, the other ropes could carry the load until the engine could be shut down. As there is some elasticity in the rope, it is not certain that tightening devices would be required, but if they were they do not seem to be impracticable.

It will be seen that this discussion applies to the driving of dynamos of all kinds, without reference to the work being done. In arc lighting, the load is frequently nearly constant, but in incandescent plants, and for street railway work, the power required at different hours of the day and night varies greatly. The amount, and hours of loading seem, therefore, to be the factors upon which the selection and arrangement of the steam plant are most largely dependent.

Electric Motors.

Mr. F. L. Pope, the well-known electrical engineer of this city, contributed the following interesting statements to a recent number of the *Journal of Commerce:*

One of the ablest modern writers on industrial questions lays down the proposition, that the limitations of the advantages derived from the use of any form of force for industrial purposes are fixed by the possibility of distributing the power cheaply and economically, and, furthermore, that of the two factors, the power to distribute cheaply is of far greater importance than the power to produce cheaply. In illustration of this proposition, consider the cheapest source of energy now known, namely, the power of falling water. It has not been found possible to effect the distribution of this form of power except over very limited areas, from which it follows that all the industrial benefits derived from water power have necessarily been concentrated in the immediate vicinity of the point of its origin, and hence, when such places have been conveniently situated in other respects, they have acquired great industrial and commercial importance. Such instances may be found at Lowell, Lawrence, Manchester, Fall River, Holyoke, etc.

On the other hand, there are instances of very extensive and valuable water powers which cannot commercially be utilized, by reason of their geographical or topographical situation; such, for example, as the water power at Falls Village, Conn., one of the finest in New England, which is practically unavailable because there is not level ground enough in the vicinity to afford sites for the necessary factory buildings, tenements and adjuncts.

Scattered all over New England, and, in fact, most of the Atlantic States, are innumerable mill sites of from 50 to 1,000-horse power, many of which were improved in former days, but which are now lying idle and contributing nothing to the industrial wealth of the community, by reason of their remoteness from modern facilities of transportation and other inconveniences of their situation. Every horse power of energy thus running to waste would be worth to the community from $50 to $100 per year, were it so situated as to be utilized to the best advantage.

It is manifestly an important part of the mission of modern electrical development to render all this waste power once more available for industrial purposes. Every increase in the limits of the economical distribution of power increases the opportunity for employment, adds to the ease, convenience and comfort with which the artisan accomplishes his work, and enlarges the surplus wealth for the community.

The two countries which have made by far the greatest advances in the utilization and distribution of electric power are Switzerland and the United States. It is well known that Switzerland is disadvantageously situated as a manufacturing country, for the reason that, although it is supplied with an almost unlimited number of the finest water powers in the world, situated upon unfailing streams fed by the melting of Alpine snows, yet these are located, in almost every instance, in inaccessible valleys and ravines, where economical transportation of heavy products is impossible. The railroad lines are situated in the main valleys at too great a distance from the water powers, in the majority of cases, to render them of much value. Steam power, on the other hand, is expensive, as there are no coal mines in the republic, and the coal used must be brought many hundred miles and up heavy grades, which render it so costly that the Swiss manufacturers have been unable to compete successfully with those more favorably situated in countries in closer proximity to the iron and coal districts. The manufacturers of Switzerland have, for this reason, heretofore been confined to the lighter and more delicate varieties of machinery, in which the cost of labor is the principal element, and the cost of transportation an inconsiderable one.

The recent introduction of methods of transportation and distributing power by electricity is rapidly changing this state of affairs, and in a few years it is probable that Switzerland will become one of the foremost manufacturing countries of Europe in all those varieties of industry in which cheap power is an important element, such as the manufacture of steam engines, locomotives, and heavy machinery, of paper, cotton, and woolen goods, and the like.

In the ancient city of Solothurn, in the northwestern part of Switzerland, there is a manufactory of machine screws which is driven by an electric motor of 50-horse power, which derives its energy from a turbine wheel which is situated on a mountain stream at a distance of over 5 miles from the works. The electric current is conveyed upon wires not larger than an ordinary lead pencil, suspended upon poles on the public highway. No one would notice any difference between this line and the ordinary telegraph line; and, in fact, there is no difference except that the construction is rather more substantial and the insulation more carefully attended to. The proprietor of the factory informed Mr. Pope that his electric motor had been running 11 hours a day for over two years, and had never been out of order for a moment. and had required no repairs; he could not say too much in its praise.

The gentleman also visited a delaine mill at Derendingen, Switzerland, of 36,000 spindles and the necessary complement of other machinary. The factory was driven by a pair of electric motors of 280-horse power deriving their energy from a turbine wheel situated about 12 miles from the factory, the connection being made by a line of insulated copper wire similar to the one at Solothurn. The manager of this factory told exactly the same story. He had never had any trouble whatever with the motors, that had been running for a year without repairs, and appeared likely to run for an indefinite length of time. He considered it far superior to any other form of power, especially in the manufacture of the delicate white woolen goods, in which the absence of smoke, cinders and dirt from a steam-engine was a particularly desirable condition. This is also the case in paper-making and other industries of like character. The cost of this electric installation at Derendingen, including the electric generators, electric motors, and connecting conductors, was about $15,000 of our money, or about $54 per effective horse-power. The cost of attendants, repairs, and maintenance is trifling.

There are several other instances of electric power transmission in Switzerland. One of these, at Lucerne, carries 120-horse power half a mile, and another 250-horse power a quarter of a mile. From what Mr. Pope saw, it was quite clear that there could be no possible difficulty in conveying even 1,000-horse power at least a distance of five miles, and there is no reason to suppose that this distance is anywhere near the possible limit which may be attained.

The installations described were put in by the Oerlikon Machine Company, whose works are near Zurich, and employ about 800 men. The visitor was informed that, in consequence of the success of the plants at Solothurn and elsewhere, their books were crowded with orders, and, especially, that they had received an order from Northern Italy for a much larger plant than any which had yet been erected.

We have no examples in the United States of anything like this amount of power being transmitted and utilized by a single motor. The writer says he does not know of any motor which has yet been set up of over 60-horse power. The development of power transmission in the United States has been mainly in the direction of distribution from a common source of energy to many small motors. Recent returns afford a basis for an approximate estimate that there are as many as 6,000 electric motors to-day in use in the United States, for industrial purposes. These have a capacity varying from the small one-sixteenth horse power which is used to drive a family sewing-machine up to the 50 and 60 horse-powers motors employed in mining and milling works. One of the most common and favorite sizes is 10-horse power, of which large numbers are in use in New York, Boston, Baltimore, Rochester, and many other places.

Every manufactory of electric motors in the United States is crowded to its utmost capacity in its efforts to meet the constantly increasing demands for electric power. Mr. Pope thinks it is, apparently, only a question of time, and not a very long time, either, when it will be difficult to find in any city a steam-engine of less than 50-horse power capacity, the demand for smaller motors being met so much more conveniently and economically by the electric motor.

Iron Roofs.

[Abstracts from a paper prepared for the Connecticut Association of Civil Engineers, by Mr. C. M. Jarvis, and read before the meeting (in the absence of the author) by Mr. B. K. Field.]

It is the purpose of the writer to deal with manufacturing buildings as illustrated, in a measure, by the practice now prevailing among the manufacturing corporations of New England.

Styles of Construction.—There are as many different styles and forms of iron trusses for roof purposes used as there are different needs for different styles and outlines of buildings, from the plain hip roof, generally made with a Fink truss, to the Mansard and arched forms of trusses which are used for depots and train sheds.

Iron roofs are built either with riveted or pin connections, depending on the span, conditions of loading, etc. Spans of 60 feet and under, and sometimes longer spans, are almost invariably built with riveted connections.

The style of roof truss to be used depends on the span, condition of loading, surroundings, etc.

Iron buildings are usually one story high, and constructed of iron roof trusses, supported by iron columns on the sides, spaced from 10 to 18 feet apart, according to the circumstances.

The columns are connected with angle-iron purlins, and then covered with corrugated iron—a very simple form of construction, and one particularly adapted to locations where it is difficult to procure a good foundation for brick walls, or in cases where every inch is valuable, and you do not wish to take up valuable space with a thick brick wall, as the corrugated iron does not take up more than 1 inch of space for side walls.

Capacity.—The capacity of an iron roof varies with the location the same as with highway bridges, and is estimated at from 30 to 60 pounds per square foot of roof surface.

Live Loads and Shafting.—Where buildings are exposed to severe winds and in northern latitudes, where there is liable to be a large accumulation of snow, 40 pounds per square foot is none too great capacity. The capacity also depends somewhat upon the construction; for example: A very steep roof over a building constantly warmed to such a degree that no snow will ever accumulate upon the roof, does not need as great a capacity as a flat roof over a building which is only heated to a medium temperature where the snow is liable to remain for some time, and to accumulate moisture from rain or the surrounding atmosphere.

Again, different roofs in the same building and different trusses in the same roof may require heavier capacity over certain portions where the snow is more liable to accumulate than over other portions where it may discharge itself easily.

Many roofs are built with the idea of carrying loads back and forth through the building by means of a trolly and cranes suspended from the trusses, and when occasion requires this, special precautions should be taken to have the trusses well braced and of a sufficient capacity to carry these loads. Roofs often built for a live load of two or three tons are loaded with two or three times this by ignorant employes who do not understand that because a bar of iron will stand 2 tons with safety, that sometimes three times that amount will rupture it, and twice that amount is liable to strain it beyond the elastic limit.

Most manufacturing buildings also require roofs to support shafting, and their capacity depends in a great measure on the size of the shafting used, and also upon the amount of pull from the belting carried by the overhead shafting.

The amount of allowance for pulling of belting is a matter more of judgment than of calculation.

Another thing to be guarded against in building iron roofs which carry shafting is to have the trusses so well braced and stiffened that there will be little or no vibration owing to the shafting being out of line or unevenly balanced pulleys.

At the present time there is a good deal of trouble in securing large pieces of timber which are well seasoned, and if the rafters and tie-beams are made of three or four pieces, owing to the unequal shrinkage, the trusses or parts of the trusses are apt to warp and twist so badly as to throw the shafting out of line and thus increase the expense of power. Iron trusses contract and expand from change of temperature with a uniformity which does not affect the shafting or the walls if proper provision is made for it; but it is the unequal swelling and shrinking of wood trusses which causes trouble. The timber when put in is generally green, and as most buildings are warm and well ventilated, it soon gets very dry and well seasoned and very liable to season crack and weaken the trusses, oftentimes to one-half their capacity.

Many times manufacturing establishments shut down for two, three or four days, and sometimes as many weeks, and are then cooled off and admit the roof to absorb enough moisture from the surrounding atmosphere to cause the trusses to get out of place from the swelling of the timbers. All this causes the shafting to get out of line, and also increases the expense of power.

Unit Strains.—Under ordinary conditions the unit strains may be taken at 15,000 pounds per square inch in tension, and 12,000 pounds per square inch in compression, reduced by proper formulæ, as the loads are generally of a stationary character; but where large pieces of machinery are to be raised, or heavy shafting suspended from the trusses, the unit strains should be the same as for highway bridges, viz., 12,000 pounds per square inch in tension, and 9,000 to 10,000 pounds per square inch in compression, reduced by proper formulæ.

Wherever live loads are to be considered in the construction of iron roofs no part shall be strained under these live loads, and including the dead weight of snow and roof to exceed 12,000 pounds in tension, and 9,000 to 10,000 pounds in compression, reduced by proper formulæ.

The particular advantage of a building with an iron roof rather than a wooden roof is that iron will not burn, and is, therefore, practically fire-proof. There is no such thing as a fire-proof building for anything, whether made of iron or wood; for no matter what it is composed of it will burn if sufficient heat can be generated; but a building made of iron, if properly constructed, has nothing about it to catch fire.

The writer had occasion two years ago to design an iron roof over the muffles in a large brass mill. The main portion of the mill was made entirely of wood with a sheet iron roof; but as there was no fire in any part of the building it was deemed by the insurance company as a good risk. The owners, however, were afraid of fire being communicated from the muffles, and therefore built this building of brick, with an iron roof, and well ventilated on the ridge so as to carry off the smoke, gases and sparks.

Unfortunately during a night run the main mill took fire from a hot box, but being so poorly ventilated, and the muffle room so well ventilated, the flames drew through into the muffle room, as they could not escape owing to the iron covering of the roof of the main mill.

The result was that the iron roof over the muffles soon collapsed.

Here was a case where an iron roof was practically useless as resisting fire; at the same time it was not designed for this purpose, but was designed to prevent a fire from starting in the muffle room.

Had there been a brick or iron partition between the two buildings, with sliding doors, the iron work of the muffle room would easily have resisted the heat of the burning main mill.

Purlins.—The purlins of an iron building should not be placed over 30 inches apart, and should be made of angle iron and well bolted to the trusses. It is bad practice to use wooden purlins on an iron roof, especially if the covering is made of iron, or even of boards, for sparks often light in the cracks between the purlins and the boards; and at night, after the factory is shut down and no one around to watch, a fire will start up and endanger the loss of the whole plant.

It is advisable where more or less wood must of a necessity be used, to keep wood from wood, and where it must come in contact to place a piece of sheet iron between.

One great disadvantage of a roof covering composed entirely of iron is the fact that in cold weather the outside temperature causes the hot air of the inside to lose a portion of its moisture, which condenses on the under side of the roof and drips. This trouble is found in roofs covered with slate as well as covered with iron. To guard against this it is necessary to have a layer of roof boards and tar paper under the corrugated iron covering, or else to use Field's patent fire-proof drip catcher, which consists of wire netting, asbestos and tar paper.

This is particularly applicable to electric light company buildings, as under no circumstances is there anything which can catch fire, no matter how much exposed or to how severe a heat, and the only fire which can injure the building is a heat which will destroy the strength of the iron.

Iron roofs covered with slate are not to be recommended, as the contraction and expansion of the iron trusses is apt to work the slate loose in time and cause trouble.

For small engine house roofs, vaults and that class of work, a roof made of girders with corrugated iron arches and concrete filling, especially if the exposure is very severe, is to be recommended. These, however, are expensive, but very effective as a fire protection, but too expensive for roofs of any considerable span.

Cost.—An iron roof for short spans (say 60 feet and under) is more expensive than a wooden roof, but when we come to longer spans designed to carry heavy machinery and shafting, the additional cost is very

trifling—in fact the writer has been assured by several who have purchased iron roofs that, in their individual cases, their iron roofs have cost them no more than a wooden roof of equal capacity.

An iron roof is just as much a mechanical and scientific construction as an engine, and the parts can be as accurately calculated as the parts of an iron bridge. Wooden roofs are, as a rule, designed by the rule of thumb, and while some parts are made excessively heavy, other parts are often decidedly weak, and as the strength of any structure is determined by the strength of its weakest member, there is a waste of material and consequently of money.

As a gentleman remarked to the writer recently, referring to an iron frame for a coal bin: "I want the most economical design you can find that will fill the bill, as I consider the design that costs the least money, and can be guaranteed to do the work, the one for me."

Waste of material by ignorant designers has cost the world millions upon millions of dollars, but there is no excuse for such waste to-day.

Appearance.—For large public halls and armory buildings iron roofs are particularly adapted, not only on account of the cost, but on account of the general appearance.

Compare the well-constructed, well-built and well-designed wooden roof of the Meadow street armory, in New Haven, with the iron roof over the armory at Bridgeport, or at Hartford, and while both have been carefully designed by competent hands, one cannot fail to notice the better appearance of the inside of the building where the iron roof is used.

Discussion.

A Member—What you refer to as an iron building is corrugated iron?

Mr. Field—It is iron throughout; there is no wood on it; iron sides, instead of brick sides.

Mr. Mackenzie—I would like to inquire something in regard to the cost of wire netting - such roof as ordinarily used for electric light stations, and how attached to the under side?

Mr. Field—We put iron purlins, from two feet to thirty inches apart, longitudinally with the building. On top, we stretch fine-meshed wire netting, probably half-inch mesh. At the Narragansett Electric Light Company, at Providence, we have two thicknesses of asbestos paper on top of two thicknesses of tar paper, the whole placed on the wire netting. That is only to prevent moisture, which will condense, from dropping on the dynamos below. The iron is cool because the atmosphere outside cools it. The hot air under it will condense and run down the purlins and drip. This roof costs two or three times as much as wood.

Mr. Mackenzie—What is the ordinary life of corrugated iron?

Mr. Field—The life of a corrugated iron roof depends on what gauge of iron you use, or whether you use it galvanized. You can put it on to last one hundred years, but, ordinarily, it will not. Iron near the seashore will go faster than inland. There are instances where that iron has lasted twenty to twenty-five years. Other times it has gone in five or six. There is no repair except to put a new sheet on. You can take off any one sheet and renew it. We have had roofs on our place seventeen years, and they do not leak very badly now. We keep them painted. A good many places where they have lost corrugated iron roofs, they have not painted them. We use metallic paint. Those that last the longest are galvanized iron. Many people put on 26-iron, which is not much better than paper. If they will put on 18 or 20 galvanized, they will have a roof to last practically forever. They put on 26 frequently. There are three or four gauges—Standard, Birmingham and others—and you must be posted on what gauge you are buying, for 26 in one might be 28 in another man's. You gauge it by the weight per foot.

Ammonia as an Antiseptic.

Some years ago Dr. B. W. Richardson, in a communication to the Medical Society, called attention to the antiputrescent properties of ammonia, and showed that blood, milk, and other alterable liquids could be preserved for a long time by adding to them certain quantities of solution of ammonia, and solid substances, such as flesh, by keeping them in closed vessels filled with ammonia gas. Some doubts that would appear to have been raised as to the results reported, on the ground that ammonia was itself a product of decomposition, induced Dr. Gottbrecht, of the University of Greisswald, to repeat the experiments, with the result of practically confirming all Dr. Richardson's statements. After some preliminary experiments, in which animal matter placed in 5 per cent. ammonia solution was found free from putrescence after nearly two years, ammonium carbonate was used in the place of the free alkali for the sake of convenience. The first experiment made with the washed intestines of freshly killed pigs showed the power of ammanium carbonate to retard putrefaction to be directly dependent upon the concentration of the solution—a 1 per cent. solution retarding it until the the third day, and a 10 per cent. solution until about the sixtieth day. When added to gelatine in which putrefaction had already been set up by inoculation, it was found that a 5 per cent. solution so modified the conditions that the putrescence ceased, and a 2½ per cent. solution inhibited the development of bacteria, so that the liquefaction of the gelatine was practically stopped. Other experiments showed that in an atmosphere impregnated with ammonium carbonate meat could be kept for six months, and at the end of that time remain nearly unaltered.

Dr. Gottbrecht also discusses the conditions under which products of putrefaction may act prejudicially to the originators of the putrefaction. This he believes to be due to a toxic action dependent on the degree of concentration. He points out that cadaverine, a product of decomposition of a cadaver, in certain degrees of concentration acts as a direct poison upon the abscess cocus, and he concludes that, similarly, all products of tissue change in living organisms can become noxious to their originators as soon as their quantity exceeds a certain limit.

Early History of the Thermometer.

A particularly praiseworthy aim of the present enlightened generation is the desire to learn the interesting incidents which generally surround the origin of many useful inventions that now hold such important places in the scientific world. The origin of the thermometer, the subject of this brief sketch, is, unfortunately, says *The World's Progress*, shrouded in the mystery of past ages, as is the case with some other great inventions. It is said that in Italy, which, during the latter portion of the middle ages, was distinguished by the attainments and discoveries of its scientifie men, the novel idea of measuring the degree of heat presented by the atmosphere at different periods was first conceived.

In a work published in 1626, the author, a physician named Santorio, of Padua, claims the honor of having invented the thermometer. The same claim is made by Cornelius Drebbel, of Alkmaar, in Holland. It appears, however, that while Santorio was the first to point out the use of the instrument, Drebbel had also discovered and made its properties known before he heard anything of the invention of the Italian physician. For some time after it was invented the thermometer was used principally for ascertaining the changes of temperature. The instrument was of the simplest kind. A glass tube was formed with a ball at one end, and the other end was open and inserted in a vessel partly filled with mercury or colored spirit. Previous to this the air inside the instrument was heated by a lamp, so that when the temperature of the atmosphere was increased, it caused the air within the ball and the tube to be rarefied. As this expanded and occupied more space it pressed down the spirit; on the contrary, when the temperature was reduced, its pressure upon the surface of the spirit decreased, and the latter was forced higher up the tube, as the quantity within became contracted in bulk. A scale was then fixed beside the tube divided into degrees, so that the several changes could be measured as correctly as might be expected from the simplicity of the contrivance. The invention soon attracted the attention of the celebrated Robert Boyle, who had already made great improvements in the air pump, and shortly after the year 1646 he engaged in the attempt to improve the thermometer. A French philosopher, named Amontons, invented an air thermometer in 1702. It was about 4 feet long, and consisted of a tube open at both ends, one end turning up and terminating in a ball with an aperture, so that there was the pressure of two atmospheres on an enclosed column of mercury, which was about 26½ inches in length. Some spirit floated on the top of the mercury, and in this a piece of wire was inserted, while on top was an index which showed the various changes on the scale attached to it.

Some of these thermometers were tolerably correct in their working; but they were all defective in one particular, since the several expanses of the air are not exactly in proportion to the heat contained in the atmosphere. To remedy this the members of an Italian academy, towards the middle of the 17th century, constructed instruments in which alcohol or spirit of wine was used instead of mercury. In that case the instrument was much like those of the present day.

The thermometer which is now in general use is a slender tube of glass, terminating in a ball containing mercury, the air having been expelled and the tube afterwards hermetically saeled. The idea of employing mercury for the purpose of measuring degrees of heat by its expansion is supposed to have first occurred to Dr. Halley, but he did not employ it, owing to the range of its expansion being much less than that of alcohol. While the invention of the mercurial thermometer is ascribed to Reaumer in 1709, it was not till 1724 that this instrument was known in this country. In that year a mercurial thermometer, which had been

invented by Fahrenheit, of Amsterdam, in 1720, was described in a paper read to the Royal Society, in which it was shown that the mercury more nearly represented the alteration in the amount of heat in the atmosphere than either alcohol or air.

Other kinds of thermometers have been invented for combined purposes. One of the chief of these is rather a barometer and thermometer united in the same instrument. Another, in which colored sulphuric acid is employed as an indicator, is, in fact, two thermometers, and is termed a differential thermometer. A curious fact to be noted in this connection is the kinds of thermometers adopted by the different countries. For instance, the Fahrenheit (German) is the one in general use in this country; the Germans use the Reaumur (French); while the French adopt the Celsius (Swedish), calling it Centigrade.

The services of the thermometer prove to be invaluable in illustrating many important and interesting phenomena of heat. Thus the ascending and descending currents produced in water when heated are due to the water becoming lighter, which phenomenon is applied in warming buildings by means of hot water pipes proceeding from a boiler in the basement. Faraday discovered the fact that two pieces of ice, when pressed, would freeze together, even in hot water, and this has been further illustrated by pressing crushed ice into various shapes of moulds, thus giving the true theory of the formation of a snowball.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

Mr. Reginald Murray, Geological Surveyor to the Victorian Government, has made a report to the Home Office upon the brown coal deposits of Gipsland. Mr. Murray remarks, in the first instance, that although the term brown coal is used, the deposits to which it is applied vary in character. While in some places they show the distinctive woody structure of lignite, in others that formation is so far obliterated as to warrant the use of the term coal. The principal areas in which this material is found are in the vicinity of the Latrobe and its affluents, the Morwell and the Moe, and underneath some of the slopes of the adjoining ranges. The total extent of these districts is computed by Mr. Murray to be over 100 square miles. For 20 years past the existence of these deposits has been known, but it is only recently that systematic attempts have been made to work them. The fuel possesses the character of a brown coal, the woody structure being almost entirely absent; and Mr. Murray, from personal observations, testifies that it burns well and cleanly, with good heat, no unpleasant odor, and little ash. The vertical thickness of the deposit in one locality is said to be immense, bores in some instances proving a thickness of seam of over 132 feet. Mr. Murray is firm in the belief that the field is bound to be a most important one.

Mr. G. F. Macmun, Superintendent of the Natick (Mass.) Gas Light Company, has during the past year, and in the face of determined opposition from the local electricians, nevertheless been able to make a good showing. In fact, to quote his own words, the outlook at Natick for progress on the side of the Gas Company is brighter than ever. Here is what the gentleman says in respect thereto: "We have this past year put our works in good condition in every respect, and have also made some extensions to our main system. We have expended more money for repairs, etc., during the last year than in any five previous years, and also declared our annual dividends of 8 per cent. for the stockholders. Indeed, we now feel better able to fight the battle than ever." That is the sort of news which we like to publish.

The proprietors of the Danvers (Mass.) Gas Company are now selling gas at $2.70 per thousand for illuminating purposes, the rate for gas used for cooking, heating, and power purposes being $2 per thousand. Next season the Company will likely make important main extensions.

About a fortnight ago the Editor of a certain well-known Western newspaper "remarked," in his "editorial squibs": "We have no doubt our readers will all agree with us when we say that we ought to have cheaper gas." Some days afterward that Editor was surprised at the receipt of a letter, bearing the signature "Many Readers," making the following inquiry: "Then why in Sam Hill don't you put down the price of your paper?"

Darwin A. Henry, an expert electrician, and Superintendent of Construction for the East River Electric Light Company, of this city, was instantly killed in the dynamo room of the Company's plant, on the afternoon of the 2d inst. He was engaged in an attempt to pass a live wire down behind the switchboard to connect the former to a new "double-throw" switch. The ladder on which he was standing shifted, and to save himself from falling he thrust his disengaged hand against the board. Unfortunately, he caught the brass feeder-bar of the switchboard, and the current felled him. He died instantly. Deceased was a son of Mr. Charles B. Henry, Superintendent of the Standard Underground Cable Company, of Pittsburgh, Pa.

It is announced on pretty good authority that the long contest between the New Brunswick (N. J.) Gas Light Company and the local electric light suppliers is about to be brought to an end. The proprietors of the Gas Company will dictate the purchase terms.

One of the very interesting exhibits at the Paris Exposition is that of M. Deleiul, of Paris, who, amongst an excellent collection of balances and other chemical apparatus, shows a beautiful set of gas testing apparatus, on the model of that employed by the city of Paris. This portion of the exhibit consists of a Dumas and Regnault's photometer, an experimental gas meter, a clock, a Bengel standard photometric lamp—illuminating power of the same being equal to 1 carcel, the French standard of light, equal to about 9.6 candles—and an automatic balance by which the quantity of oil consumed in the standard is weighed, and which indicates by a stroke on a bell the beginning and the finish of the experiment.

Supt. Adams, of the Richmond (Va.) city gas works, is completing an extensive system of betterments on that plant. The old retort house walls have been raised 7 feet, and the building is to be covered with an iron roof of the trussed pattern. The bench additions will put the plant in position to supply at least 1,250,000 cubic feet each 24 hours.

The transfer books of the Boston gas syndicate, which were closed on August 31st, are to be reopened on September 19th.

The following, from an occasional correspondent, is likely to be read with interest: "The Boston *News Bureau* recently contained the following: 'Mr. J. E. Addicks is in New York, and when he returns he will bring with him the certificates of stock of the Bay State Gas Company. A meeting of the Trustees will then be called, and the first division of assets will be made. Thus a man holding a syndicate certificate of $10,000 will receive $10,000 second mortgage 5's, $5,000 stock and a cash dividend of 2¾ per cent. It is figured the 5's will bring $95, stock $70, which, with cash dividend of $275, would give a total of $13,275 for the $10,000 certificate. There will be a division later of 33 per cent. on the full value of the original certificates in equal parts of income bonds and stocks. There are only 50,000 shares of stock, and it is stated that the stock is already earning at the rate of 5 per cent. As there is no question but that the Company is more than earning fixed charges, it is believed the second mortgage bonds should sell fully as high as the first, for the reason that they have 40 years to run.' There is a manifest purpose to sharpen the public appetite for the junior securities of the Bay State Gas Company in advance of their issue. The talk now is 65 to 75 for the stock, and ahead of that come the incomes, then the second mortgages, and then the first lien collateral bonds. These last are not quite up to par yet, and are paying regular interest. The second mortgage interest accrues from July 1, prox. There is reason to believe the Company will show a book balance for the stock at the end of the year, but whether anything will be paid on the stock, or even on the income bonds, is open to question. The consolidation of the gas companies had two aims, one speculation and one investment. The former is promoted by capitalizing the properties to the extent, at least, of their full value, and in the constant acquirement of additional gas plants. The investment character of the undertaking consists in developing the net earning power of the consolidated plant, by cheapening the costs of production and delivery, and in encouraging consumption. Economies are already great, and may be even greater as changes are brought about with prudent despatch; but let no investor forget that there is a world of difference between the primitive Massachusetts way of issuing stock certificates only against the value of gas plants, and the modern method of making certificates the last lien, with contingent income bonds and two classes of prior lien bonds ahead of these. The money is to be made off the junior securities, and while there is no wish to cheapen these, there is a desire to suggest the desirability of caution in making purchases of such securities until their value has been clearly demonstrated. A monthly or quarterly exhibit of the operations of the Consolidated Company would be the most satisfactory demonstration."

At a meeting in August of the Board of Aldermen of Middletown, N. Y., but two bids for lighting the public lamps were received, one of which was submitted by the local electric light company, the second one having been handed in by a firm of naphtha lighting contractors. The

fact that the Middletown Gas Company, which for over twenty years had lighted the principal streets, did not put in a bid excited much surprise, and for some days the failure was the talk of the town. And here comes in a very odd method of dealing. It seems that at the Board meeting prior to the one at which the bids were received, the matter of public lighting was discussed, and on the score of "economy," the Board, or a portion thereof, managed to have it ordered that the Committee on Street Lighting be authorized to *solicit* bids for lighting the lamps, instead of securing the same, as formerly, by the method of *public advertising*. Ald. Startup, as Chairman of the Committee on Lighting, in replying to an inquiry made by Ald. Wolf, which inquiry was duplicated by Mr. Sheerin, as to whether the Gas Company had been solicited to make a bid, replied in the affirmative. This reply was false; for inquiry at the office of the Gas Company disclosed the fact that the Company had neither verbally, nor in writing, been asked this year to submit figures for public lighting. In fact, it may well be taken for granted that the most greatly surprised man in Middletown was Superintendent Todd, of the Gas Company, who had been looking anxiously in the newspapers for the usual advertisement requesting the submission of bids for the public lighting—particularly as the contract under which the Company was working would expire on the first inst. The effect of this disclosure, which was speedily brought to the attention of the Board, was rather startling, and resulted in the passage of a motion to "lay over the matter of street lighting." In the meantime the City Clerk, on the advice of the City Attorney, served notice on the Gas Company, and the electric lighting and naphtha companies as well, to submit bids for the public lighting just as if no bids on the lighting for the current year had been submitted at all. Comment on the above plain statement of the facts in the case would neither add to nor take away from the duplicity of certain members of Middletown's Board of Aldermen.

On the morning of August 26, about 300 feet of the Lake Shore Gas-Coal Company's tipple, located at Ciera Station, on the Pittsburgh, McKeesport and Youghiogheny Railroad, collasped. The tipple contained two men and perhaps 14 coal cars at the time of the accident. The Superintendent (Mr. Jos. Weaver) and his brother were seriously injured.

Some weeks ago it was positively asserted that control in the Lincoln (Neb.) Gas and Electric Light Company had been sold by President Walsh and his associates to a syndicate of Missouri capitalists. This is not so for the property still remains in the hands of its original owners. It is not denied, however, that an offer was made for the plant, but the same was not accepted.

A considerable concession in gas rates has been made by the proprietors of the Atchison (Kas.) Gas Company. We are not informed as to the new schedule, but are somewhat surprised to find this statement respecting the Company in the columns of the local *Patriot*—not that our surprise is based on the fact that what the *Patriot* prints is not true. No; our surprise springs from the thought that the *Patriot* can find anything good to say of any gas company. Here is what this courageous editor tells his readers: "While other cities are complaining of the poor quality of gas furnished by their local companies, and about the high prices they have to pay for the inferior gas, Atchison is happy in having the best managed Gas Company on the Missouri river and is burning the best quality of gas in the West. The price has been recently reduced, so that it now cost but little more than coal oil." Well, Well!

As announced in our "Market for Gas Securities" report in the last issue the Hon. Edward Murphy, Jr., has been chosen President of the Troy (N. Y.) Gas Company, succeeding in that position Mr. Thomas W. Lockwood. This is the initial step in the scheme for perfecting the consolidation of the Citizens and Troy Gas Light Companies and the Troy Fuel Gas Light Company. It is also said that the local electric lighting interests will eventually come under the charge of those now in control of the gas interest.

The retort house and purifying plant of the Meridian (Miss.) Gas Company have been completely reconstructed, and on a very much larger scale than that which formerly obtained.

Mr. Charles Balcom, Assistant Superintendent at the Newton and Watertown (Mass.) works, was in this city last week. He reports a good outlook for the gas business in the Bay State.

The public lighting of San Francisco, which last month had given poor satisfaction both to the citizens and the contractors, because of the sudden development of naphthaline deposits in many of the lamp services, is now answering every requirement as to illuminating power and volume.

Mr. Allen, Clerk of the Massachusetts Board of Gas and Electric Light Commissioners, has just returned from an outing in the great lake region of Canada. He had his faithful camera with him.

Messrs. Shickle, Harrison & Howard, of St. Louis, Mo., are under contract to build a large holder (to rest in an iron tank) to the order of the Dever, Col., Gas Company.

Mr. John Gimper, the able Superintendent of the Leavenworth (Kas.) Gas Company, has completed his investigation of the water gas types of apparatus now in operation at various points in the States. This trip was made at the instance of the Directors of the Company, who were desirous of determining whether it would be in line with economy to manufacture water gas at Leavenworth. They could not have secured or chosen a better or fairer expert than "their own Gimper," and the only fault we have to find with the latter in respect to the completeness of his recent tour, is that he did not manage to find his way to 42 Pine street.

The medical fraternity of Erie, Pa., are using the local gas works as a sanitarium for their patients afflicted with whooping cough. One day last week Superintendent Hill furnished accommodations for no fewer than 19 such sufferers.

The Georgia Gas Company, of Chattanooga, Tenn., has been incorporated.

The projectors of the Hyde Park (Chicago) Mutual Fuel Gas Company say that they will be in readiness to furnish gas on or before February 1st. The plant is to be located on Langley street, close to the tracks leading to the stock yards. The process to be employed is similar to that in use at Jackson, Mich., and the rates at which the gas is to be supplied are: For lighting purposes, 75 cents per 1,000; for fuel use, 50 cents per 1,000.

The Spencer (Mass.) Gas Company is introducing in that town the "Union System" of house heating. This is nothing more than maintaining a system of heating by hot water, gas being used as the heating agent.

A certificate incorporating the National Fuel Gas and Water Works Construction Company was recently filed by Messrs. Charles B. Harris, of New York, Frank D. Moses, of Chicago, and Moses H. Daniels, of Montclair, N. J. The concern is capitalized in $100,000, and proposes to construct and operate gas and water works in Montclair. The local gas suppliers need not give themselves any trouble over this venture.

The Holyoke (Mass.) Gas Company's mains are being carried under the Appleton street railroad bridge, in order that gas may be laid on at the premises of the Merrick Lumber Company.

We understand that the Laclede Gas Company, of St. Louis, has filed a bond with the City Register in the sum of $25,000, for the purpose of assuming the contract of Chas. A. Brown (ordinance No. 15,265), who had agreed under it to light the northern section of the city by electricity for a period of 10 years. The Laclede Company is enabled to assume the contract because of a supplemental ordinance, passed Aug. 13, 1889.

Some time ago we noted that the Portsmouth (O.) Gas Company had determined to engage in the supply of electric lighting, and to that brief mention we are now, through the courtesy of a correspondent, enabled to add the following details: "The Portsmouth Gas and Electric Light Company has been incorporated with a capital of $100,000, which has all been taken by Messrs. Henry Padan, Emanuel Miller, M. R. Tewksbury, F. B. Kehoe, W. M. Pursell and W. C. Silcox. It is the intention of the proprietors to go to work immediately and as the plans for the building are in the hands of Architect Ayer, it is likely that in less than three months the plant will be in operation. The building, which will be located on the site of the present office of the Company, is to be a 1-story structure, and is to be 35 by 70 feet in dimension. Although plain in appearance, the building will be sufficiently ornamental for its purpose, and will be surmounted by a tower, in which will be placed a water tank. An Otto gas engine of 72-horse power, to be stationed in the basement, will supply the power; and the dynamo capacity will be equal to the supply of 1,000 incandescent (16-candle power) lamps. The contracts for the apparatus, works, poles, etc., have been awarded, and Superintendent Wilkiemeyer, who, by the way, is wonderfully popular

in the district, can be depended on to keep the contractors up to their work. He has made many betterments on the gas plant, and the service of the Gas Company has never been so good as at present. Perhaps the reduced gas rate (it was cut not long ago from $2 to $1.75 per 1,000) may have had much to do with the increased prosperity of the Gas Company; but there can be no blinking the fact that the new Superintendent's methods are of the sort calculated to win favor.—A. T. T."

FRED. S. CLARK and his associates assert that they have raised the capital ($500,000) necessary to go on with the proposed fuel gas supply for Grand Rapids, Mich. It is not claimed that plant construction work will be begun this winter, the idea being to prepare the distribution system in advance of the works proper. We are of the opinion, however, despite all the bluster of the promoters, that the promised supply of fuel gas at this point is not really meant. The object behind the agitation is to obtain control of the existing Gas Company.

THE decision of the courts in respect to putting an embargo on the construction of the plant of the opposition Gas Company at Elizabeth, N. J., has been given. It is favorable to the opposition, the promoters of which are pushing things vigorously.

THE Stacey Manufacturing Company will build the telescopic gasholder, proposals for which were recently asked for by the Board of Gas Trustees, Hamilton, O. The bid price was $21,400.

THE 43d annual meeting of the stockholders of the Providence Gas Company was called to order by President Amos C. Barstow, and Secretary A. B. Slater read the records of the last meeting, which were approved. President Barstow then read the 42d annual report of the Board of Directors, which covered the year from July 1, 1888, to July 1, 1889. The production of gas for the year was 438,974,000 cubic feet, an increase over the previous year of 34,492,000 cubic feet. The net receipts for the year from products were: Coke, $39,171.59; tar, $8,766.37; ammonia, $5,693.23; total, $53;637.19, a gain over the year preceding of $2,703.03. The quantity of coal carbonized was 39,723 tons. The Board had been able to make a further reduction in the price of gas. The Board have investigated the question of making water gas, and have ordered a full set of apparatus for the manufacture of water gas, but will maintain all the coal apparatus intact, in case they should have to return entirely to it. The water gas properly mixed with coal gas, it is believed, will give a superior quality of gas, as in some respects water gas possesses advantages over coal gas. An extended trial, however, can demonstrate this beyond any doubt, and the Board will certainly use nothing but the best means of illuminating. Since the last addition of capital stock the Company has not only more than doubled its production of gas, but has reduced the price to $1.40. The increasing consumption within late years for cooking purposes will still further tend to reduce the price of gas. The Company closed the year entirely free from debt. The next business was the election of nine Directors, and the following named gentlemen were elected by a *viva voce* vote: Col. William Goddard, Hon. Amos C. Barstow, Alpheus B. Slater, Hon. Royal C. Taft, Edward Pearce, Jesse Metcalf, Amos N. Beckworth, George W. R. Matteson, Lucian Sharpe. There being no further business, the stockholders' meeting adjourned. Subsequent to the adjournment of the stockholders' meeting, the Directors held a meeting and organized with the selection of officers to serve for the year ensuing. These are: President, Amos C. Barstow; Vice-President, Col. William Goddard; Secretary and Treasurer, A. B. Slater. The Directors' meeting then adjourned.

LAST week Mr. Wm. A. McEwen, who has for years most acceptably filled the position of Secretary and Treasurer to the Capital City Gas Light Company, Des Moines, Iowa, was, at his own request, transferred to the home office of the United Gas Improvement Company—the latter corporation being in control of the Capital City plant. Mr. M. T. Wright, of Philadelphia, takes Mr. McEwen's place at Des Moines.

TONAWANDA, N. Y., experienced a conflagration, on the evening of August 29, that at one time looked very serious. Fortunately, the flames were extinguished before considerable damage was done. Among the sufferers was the Tonawanda Gas Light Company, the offices of which were thoroughly drenched.

THE strike among the employees of the Allegheny County Light Company (Pittsburgh, Pa.), reported in our last, was settled this week. The strikers were taken back, and the wages of the carbon-setters were placed at $2 per day. This is a victory for the men.

"I NOTE your recent comments concerning the dickering between gas and electric lighting promotors of Amherst, Mass, and believe that the negotiations will result in a consolidation of both companies. If the deal is carried through, I think the electricians—the Thomson-Houston Company is largely interested in the local company at Amherst—will have the larger share of the division.—OBSERVER."

HERMAN POSER, night watchman at the Williamsport, Pa., gas works, was pumping out a naphtha tank, on the evening of August 29. In order to see how the work was coming on he ignited a match and placed the flaming lucifer close to the mouth of the pump. An explosion followed, and Poser is now well smeared with cooling lotions. When he recovers, the riot act should be read to him.

THE following schedule is the one in force in Buffalo for regulating the time of lighting and extinguishing the public lamps—both electric and gas:

Month.	Light.	Extinguish.
January	5:20 P.M.	6:50 A.M
February	5:50 "	6:20 "
March	6:50 "	5:20 "
April	7:20 "	4:50 "
May	7:50 "	4:20 "
June	8:40 "	3:40 "
July	8:40 "	4:10 "
August	7:40 "	4:10 "
September	6:20 "	4:50 "
October	5:50 "	5:20 "
November	5:20 "	5:50 "
December	5:20 "	6:50 "

The Brush, Thomson-Houston and United States Electric Light Companies are paid 45 cents per night for each lamp—the total number of same being 1,218. The Buffalo, the Mutual and the Citizens Gas Companies receive $1.30 per 1,000 cubic feet for the gas used in 4,241 lamps, which are equipped with 4-ft. burners. The total cost of public lighting in Buffalo for the past year was $280,000, while the expenditure on similar account this year will not fall short of $300,000. Next year an attempt will be made to increase the number of hours of burning.

IT is understood that the capital stock of the Company which is to take the place of the Troy, Citizens and Fuel Gas Companies (Troy, N. Y.) will be adjusted at $1,000,000. We also believe the decision has been reached to make gas for the entire district (Troy, Lansingburgh and Waterford) at the Hill street plant, while, should the manufacturing capacity at that location be found insufficient, the Citizens works can be started up at any time. This disposes of the talk that the latter station was to be dismantled.

THE workmen engaged on the task of making the excavation for the holder of the Dalton (Ga.) Gas Company, when at a depth of 10 feet, encountered a vein of gas. It is possible that the Directors will put down a drill for the purpose of determining whether or not they have struck a voluminous supply of natural gas.

A QUEER sight was witnessed in New York harbor on the evening of Sept. 3d. A large iron-hulled ship (the Bay of Naples) was at anchor just south of the Bartholdi statue. The vessel was all in readiness to sail for Rangoon, India, on the following morning, with a cargo consisting of 55,600 cases of refined oil. Shortly before midnight a fire broke out in the cases stored under the forward hatch and a strangely weird scene was the result; for at times the flames would in intermittent flares reach to a height of 60 feet. The torch of Madame Liberty, however, shone undimmed through it all.

MR. EDWARD WELLS, an agent of the Thomson-Houston Company, is in Gallatin, Tenn., with an eye to inducing the authorities to adopt electric lighting for the streets. The contract for the public lighting now held by the Gallatin Gas Light Company will soon expire.

SENATOR INGALLS, who is Chairman of the Senate Committee on Affairs of the District of Columbia, is said to have warned the District Commissioners that they might overstep the regulations in granting a foreign corporation the privilege of tearing up the streets to lay wires, etc. This intimation was made no doubt in view of the proposed action by the Commissioners to grant the Electric Heat and Power Company the right to lay underground conduits for the supply of incandescent electric lighting in the District, and which grant is now before the courts in consequence of injunction proceedings to which the Washington Gas Light Company is a party.

THERE is some talk in St. Louis of organizing an opposition Company to compete with the syndicate now in possession of the Laclede Company's rights.

THE AMERICAN GAS LIGHT JOURNAL

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MONDAY, SEPTEMBER 9, 1889.

Gas Engines for Driving Dynamos.

The use of gas motors for operating dynamos is making good headway, and, better still, such use is attended with satisfactory results where the method of operating receives the proper attention. To show the truth of our remark that the system makes headway, we cite the following instances: A 20-horse power Otto engine is employed at Iowa City, Iowa, to drive a 40-light Western electric dynamo from which only 16 lamps are now being operated for street lights on a three-mile circuit. As soon as the number of lights is increased an additional engine will be installed. The Racine (Wis.) Gas Company is now employing two Otto gas engines—one of 15-horse power and the other of 50 horse power—to drive a specially-wound No. 8 Brush dynamo, operating sixty-two 2,000-candle power lights on an 11-mile circuit, on a total run of 955 lamp hours; the expenditure of gas was at the rate of 23½ cubic feet per lamp hour. The Grand Forks (Dak.) Gas Company is now installing a 20-horse and a 50-horse power Otto engine to drive a mixed arc and incandescent plant.

Advertising for Cheap Engineers.

The *American Engineer*, in writing on this topic, says: There are some men who seem never to improve or learn by experience and results. They are to be found in every community. Although positive evidence and undeniable facts are brought frequently and strongly to their notice, they are ready to see faults in others, and will blame them for misfortune and accident through mismanagement, oversight or carelessness, but fail to correct their own shortcomings. In their "know it all wisdom" how loud they are in proclaiming, after some disaster or accident, what should have been done; with what minuteness will they point out defects and deficiencies. But it does not occur to these men that in some details of their own affairs they lay themselves open to unfavorable criticism. We cite a single instance that fully illustrates what we refer to.

Day after day the public are informed of disasters and accidents, of destruction of life and property—the results of boiler explosions. The cause of nearly all these explosions is known. Defects in many boilers most certainly exist and are expected to occur more or less, but boilers should be in charge of men who can detect defects. The persistency of steam users in employing incompetent men to look after boilers and machinery in the face of almost daily calamities is something unaccountably strange and marvelous. The ignorance of some men put in charge of steam machinery is simply astonishing. The cool and fraudulent assumption they display in passing for engineers makes them a laughing stock. And yet steam users will advertise for cheap engineers.

Not many years ago we found boys in charge of boilers and engines at factories employing men, women and young girls. Not many years ago we read advertisements like these: "Wanted a man to take charge of an engine and boiler and mind a horse;" "Wanted an engineer to tend a boiler and make himself generally useful;" "Wanted an engineer to take charge of a boiler and engine and to do chores about the works;" "Wanted an engineer, must be sober, steady, reliable man, wages $7 per week," and so on *ad nauseam*. We had hoped that such advertisements as these were stopped, but we find the public insulted by the insertion of them, occasionally, in the daily papers. A few days ago an advertisement appeared in one of the Chicago dailies for a man to tend an engine and to make himself generally useful about the house. And so it goes. Property and lives are lost, hands are thrown out of employ, ruin and loss, distress and mourning are all about us, and yet the men we refer to, for the sake of saving a few dollars, will persist in employing "cheap engineers"—men who can throw in coal, sweep up, wipe down, waste oil, divide their attention between a stable and a boiler house; sweep out the works, run errands at meal hours, and when the boiler is not in use, labor about the yard. This is no over-drawn picture. It is sadly too true. And when these parsimonious employers are remonstrated with they will politely, or impolitely, request you to mind your own business, but seldom fail to add, "Our profits will not allow us to pay high wages to an engineer, and our machinery is so simple that any intelligent boy can run it." Shades of Watt and Stephenson! "Against stupidity the very gods themselves fight in vain."

The Market for Gas Securities.

The record for the week is that of extreme dullness. Consolidated, however, is strong, being at 88, and any order of magnitude would likely put the price at 90. Brooklyn shares are neglected, although the tone is strong. Chicago Trusts are up to 61¼. The quarterly dividend of 1 per cent. on these shares is payable on the 20th inst. to holders of record of the 7th inst. The transfer books were closed on the latter date to be reopened on the 20th. The managers of the United States Equitable Company are paying a dividend of 3 per cent. On October 3d the stockholders of the different Troy (N. Y.) Companies will vote on the proposition to consolidate the same under the name of the Troy Gas Company.

Gas Stocks.

Quotations by Geo. W. Close, Broker and Dealer in Gas Stocks.

16 WALL ST., NEW YORK CITY.

SEPTEMBER 9.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

	Capital.	Par.	Bid	Asked
Consolidated	$35,430,000	100	87¾	88
Central	500,000	50	—	—
" Scrip	220,000	—	—	—
Equitable	4,000,000	100	122	125
" Bonds	1,000,000	—	113	115
Harlem, Bonds	170,000	—	—	—
Metropolitan, Bonds	658,000	—	116	118
Mutual	3,500,000	100	102	103
" Bonds	1,500,000	—	100	102
Municipal, Bonds	750,000		—	—
Northern		50	—	—
" Bonds	150,000	—	—	100
Yonkers		50	112	—
Richmond Co., S. I.	346,000	50	60	70
" Bonds	15,000	—	—	—
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	107	109
Citizens	1,200,000	20	60	65
" S. F. Bonds	320,000	1000	—	103
Fulton Municipal	3,000,000	100	126	127
" Bonds	300,000		—	106
Peoples	1,000,000	10	75	76
" Bonds (5's)	368,000	—	97	—
" " (6's)	94,000	—	100	—
Metropolitan	1,000,000	100	88	91
Nassau	1,000,000	25	110	—
" Ctfs	700,000	1000	100	103
Williamsburgh	1,000,000	50	119	123
" Bonds	1,000,000	—	109	112
Out of Town Gas Companies.				
Boston (Mass.) Gas Co	2,500,000	500	240	—
Buffalo Mutual, N. Y.	750,000	100	90	95
" Bonds	200,000	1000	95	100
Citizens, Newark	1,000,000	50	155	160
" " Bonds	45,000	—	—	—
Chicago Gas Trust	25,000,000	100	61	61¼
Cincinnati G. & C. Co.	6,000,000	100	214	218
Consumers Toronto	1,000,000	50	190	200
Central, S. F., Cal.			80	90
Capital, Sacramento, Cal.			58	
Consolidated, Balt.	11,000,000	100	44¼	44½
" Bonds	6,400,000		107	107½
Hartford, Conn	750,000	25	120	130
Jersey City	750,000	20	175	180
Laclede, St. Louis, Mo.	2,000,000	100	140	—
Louisville, Ky	2,570,000	50	125	130
Little Falls, N. Y.	50,000	100	—	100
" Bonds	25,000	—	100	103
Montreal, Canada	2,000,000	100	200	208
Memphis (Tenn.) Gas	750,000	100	48	51
" Bonds	240,000	100	103	—
New Haven, Conn		25	200	—
Oakland, Cal.			35	35½
Peoples, Jersey City		—	60	61
" " Bonds			—	—
Paterson, N. J.		25	99	102
Rochester, N. Y.		50	99	100
Syracuse, N. Y.	500,000	25	—	—
St. Louis, Missouri	600,000	50	—	750
San Francisco Gas Co.			60	60½
San Francisco, Cal.	10,000,000	100	59¾	60
Washington, D. C.	2,000,000	20	195	198
Wilmington, Del.		50	200	208

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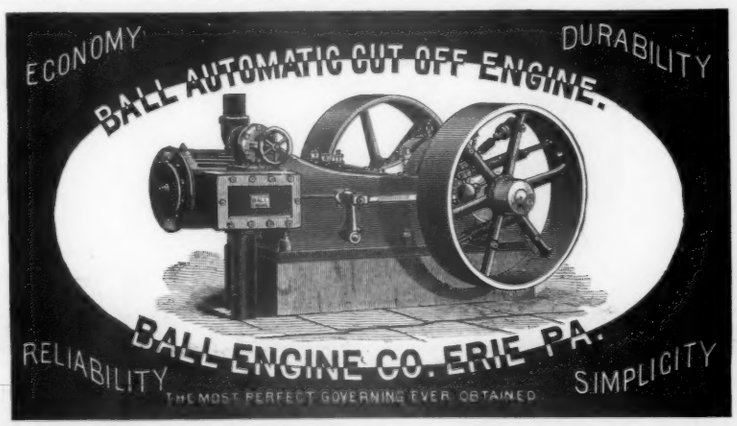

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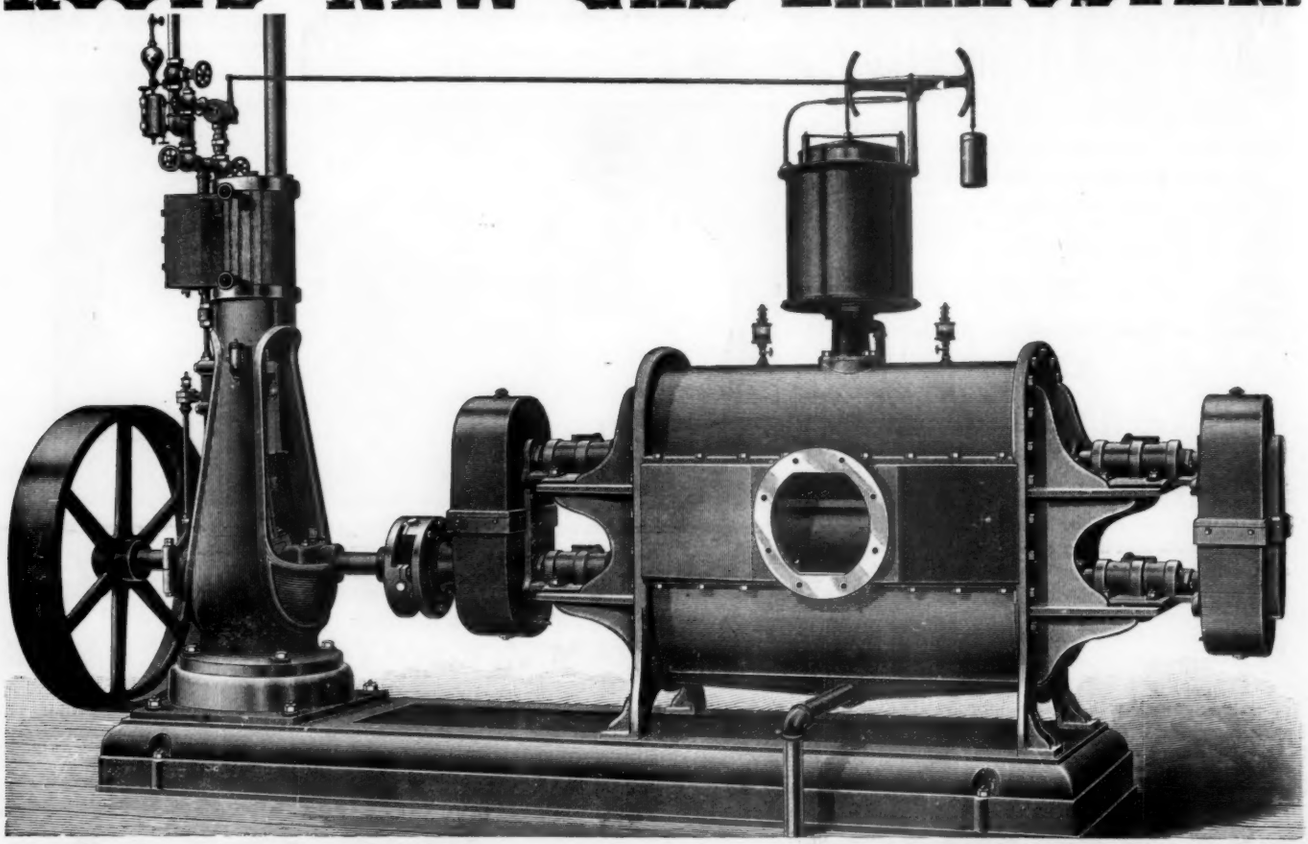

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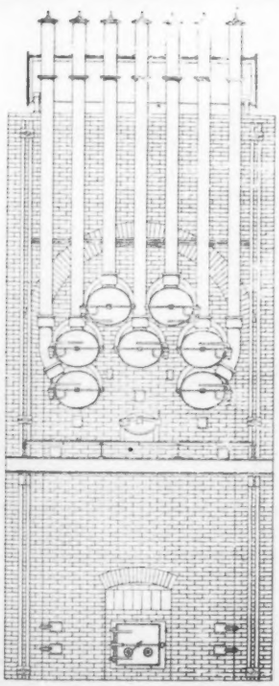

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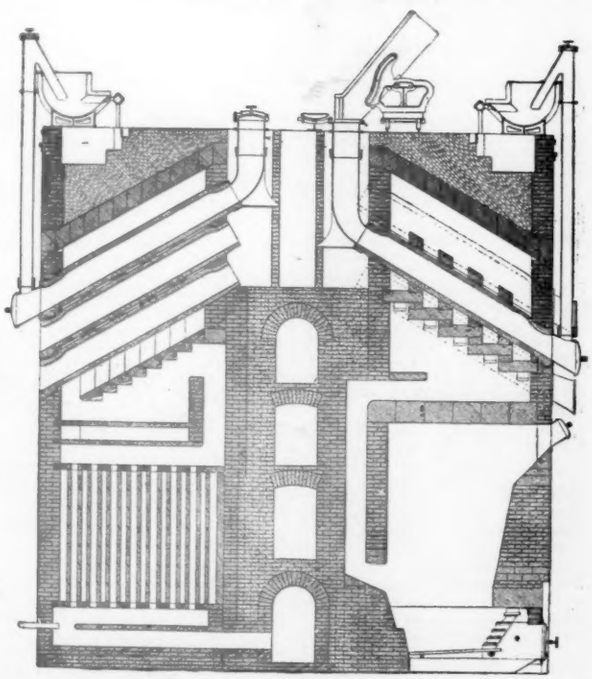

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Adelaide	600,000
Aldershot	200,000
Allegheny, U. S. A.	1,000,000
Ashton-under-Lyne	1,250,000
Amsterdam	1,500,000
"	1,500,000
Annaberg	200,000
Arcachon	100,000
Animal Charcoal Co.	200,000
Altoona, U.S.A.	350,000
Buxton	250,000
Bradford	1,000,000
"	1,250,000
"	1,250,000
"	1,250,000
"	1,000,000
"	1,000,000
"	3,000,000
Bremen	150,000
Baltimore, U.S.A.	1,000,000
"	1,000,000
"	1,000,000
Balmain, N.S.W.	125,000
Bishops Stortford	150,000
Blackpool	400,000
Brussels	1,250,000
"	1,250,000
"	750,000
"	1,250,000
Banbury	250,000
Birmingham	5,000,000
Birkenhead	2,500,000
Blackburn	1,500,000
Bochum	600,000
Burntisland	250,000
Boston, U.S.A.	2,000,000
Brisbane	1,500,000
"	300,000
Burton-on-Trent	1,500,000
Barcelona	350,000
Barking	100,000
Baerlien & Co	20,000
"	20,000
Bombay	400,000
Buffalo, U.S.A., Mutual	750,000
" **Citizen**	500,000
Brookline, U.S.A.	500,000
Bergen	350,000
Berlin	1,250,000
Bournemouth	1,000,000
Bridgeport, U.S.A.	500,000
Brunswick	300,000
Beck & Co., St. Louis	100,000
Barmen Rittershausen	600,000
Bexhill	125,000
Brooklyn, U.S.A.	1,000,000
"	1,000,000
" **Nassau**	1,000,000
Brunner, Mond & Co.	400,000
Cheltenham	2,000,000
Cannes	200,000
Croydon	1,500,000
Copenhagen	200,000
Clevedon	200,000
Columbus, U.S.A.	500,000
Cincinnati, "	1,500,000
" "	1,500,000
Chicago "	3,000,000
" "	1,000,000
" "	1,000,000
Chemnitz	1,000,000
Crewe	1,250,000
Colonial Gas Works Co.	100,000
Cadiz	300,000
Charlottenburg	600,000
Dudley	750,000
Driffield	100,000
Dukenfield	500,000
Dover	750,000
"	1,000,000
Deal	200,000
Derby	1,500,000

	Capacity. Cubic feet per day.
Dublin	3,000,000
Dowlais	100,000
Douai	500,000
Denton	500,000
Derby, U.S.A.	350,000
Denver, "	500,000
" "	1,000,000
Dusselldorf	750,000
"	500,000
Dumfries	250,000
Dunedin, N.Z.	400,000
Darlington	1,250,000
Detroit, U.S.A.	750,000
Edinburgh	1,500,000
"	2,000,000
Enfield	300,000
Essen	300,000
Elbing	150,000
Falmouth	150,000
Frankfort	300,000
Farnworth	400,000
Fenton	400,000
Friedenshutte	500,000
Furth	400,000
Freiburg	200,000
Goole	250,000
Glossop	300,000
Guildford	300,000
Gloucester	1,250,000
Gera	300,000
Grafton, N.S.W.	100,000
Grieg	300,000
Georgetown, U.S.A.	250,000
Gluckauf	200,000
Heywood	600,000
Holywood	125,000
Huy	70,000
Harrow	250,000
Harrogate	250,000
Halstead	150,000
Heilbronn	200,000
Havana, Cuba	750,000
Hastings	1,500,000
Huddersfield	300,000
"	750,000
"	1,500,000
Hof	200,000
Hampton Wick	500,000
Heckmondwicke	500,000
Haverfordwest	100,000
Halifax, N.S.	350,000
Hamm	200,000
Halle	400,000
Heidelberg	300,000
Hartford, U.S.A.	1,000,000
Ilkeston	300,000
Inverness	200,000
Ilkley	200,000
Ilford	100,000
Kingston-on-Hull	400,000
Kidderminster	750,000
Kidsgrove	100,000
Konigberg	1,000,000
King's Lynn	300,000

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The Gaslight and Coke Co.:	
Beckton	1,250,000
"	1,250,000
"	1,250,000
"	1,250,000
"	1,250,000
"	1,250,000
"	2,500,000
"	2,500,000
Silvertown	1,000,000
Bromley	2,000,000
"	1,500,000
"	1,500,000
"	1,500,000
"	2,000,000
"	1,500,000

LONDON—*Continued.*	Capacity. Cubic feet per day.
Shoreditch	2,500,000
Pancras	1,500,000
"	1,500,000
Pimlico	2,000,000
Nine Elms	3,000,000
"	3,000,000
South Metropolitan Co:—	
Greenwich	3,000,000
Woolwich	400,000
Vauxhall	3,000,000
"	3,000,000
Lea Bridge	300,000
West Ham	1,500,000
Leeds	2,000,000
"	3,000,000
"	3,000,000
"	3,000,000
"	2,000,000
Leominster	150,000
Leiden	560,000
"	600,000
Liverpool	2,000,000
"	2,000,000
"	2,000,000
"	2,000,000
"	2,000,000
"	3,000,000
Lincoln	1,000,000
"	600,000
Lowell, U. S. A.	1,000,000
Louisville "	1,500,000
Long Eaton	500,000
Lilie	900,000
"	450,000
"	750,000
"	250,000
"	250,000
Luckenwalde	330,000
Liegwitz	300,000
Lincoln, U. S. A.	250,000
Lawrence "	500,000
Lynn "	300,000
Lyons	1,500,000
Maidstone	1,000,000
Marseilles	1,500,000
"	1,500,000
Mons	500,000
Malines	250,000
Melbourne	1,500,000
"	1,500,000
"	1,500,000
"	1,500,000
"	1,500,000
Manchester	2,500,000
Middleton	400,000
Manley, N. S. W.	100,000
Minneapolis, U. S. A.	750,000
Magdeburg	300,000
Memphis, U. S. A.	750,000
Nottingham	1,250,000
"	2,500,000
"	2,500,000
"	2,000,000
"	1,500,000
"	2,000,000
Newport, U.S.A.	430,000
Newmarket	150,000
Newark, U.S.A.	680,000
Northfleet	200,000
New York, U.S.A.	2,000,000
Nice	600,000
Newcastle, N. S. W.	200,000
Numea, "	100,000
Namur	250,000
Newark	350,000
Oldbury	500,000
Otley	200,000
Oswestry	250,000

	Capacity. Cubic feet per day.
Ober Schlesian	1,500,000
Otto & Co.'s Coke Works	1,500,000
Plymouth	2,000,000
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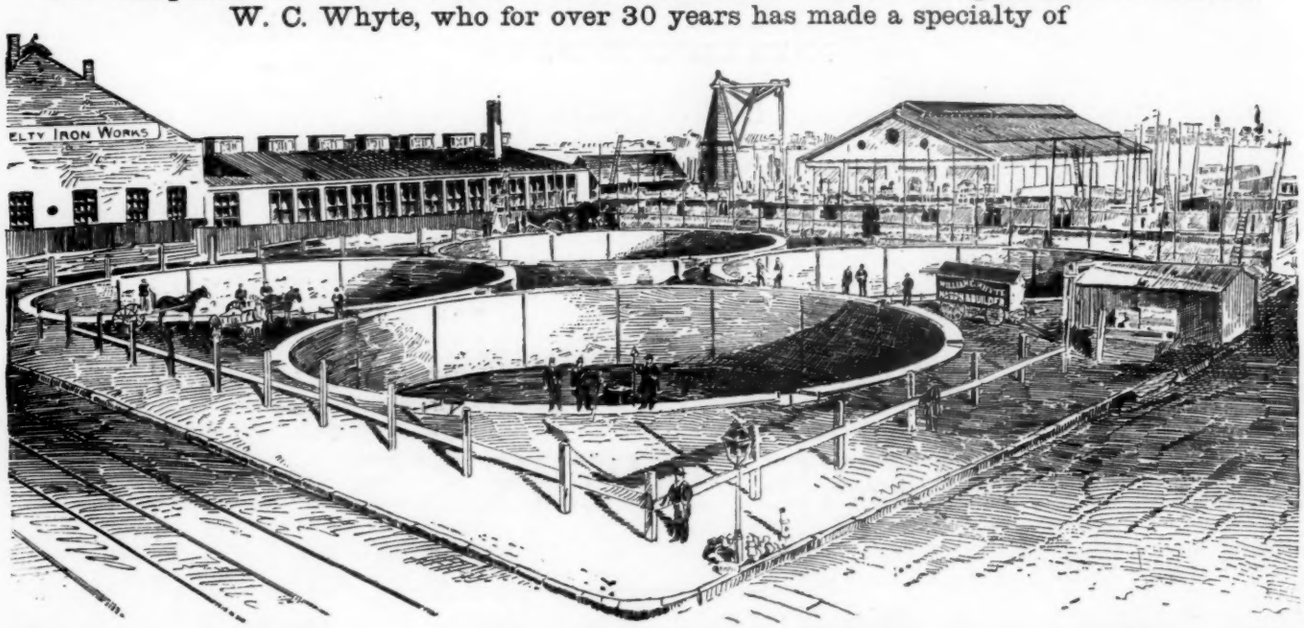

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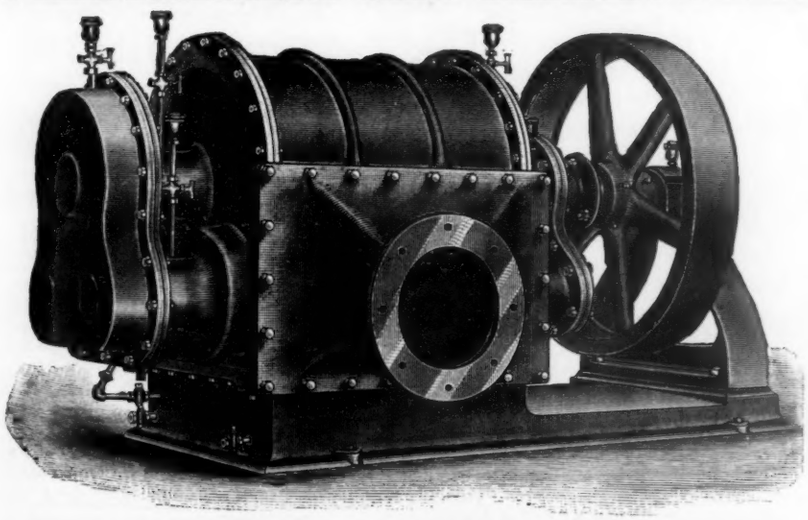

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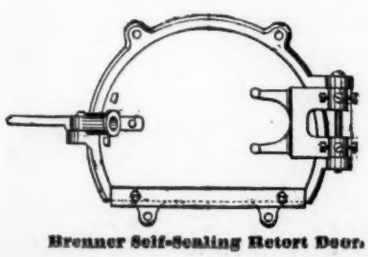

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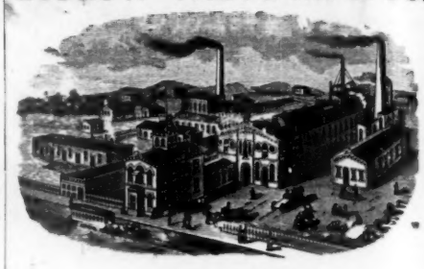

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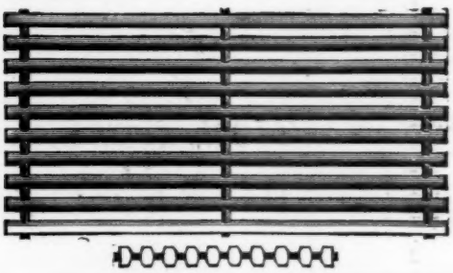

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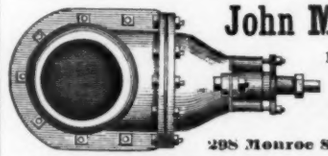

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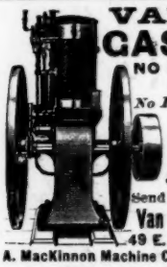

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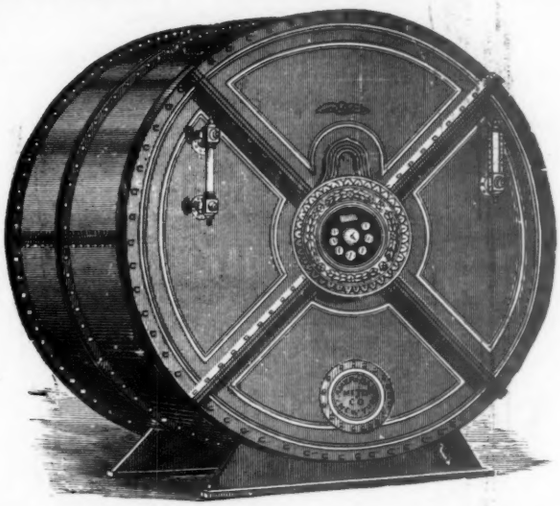

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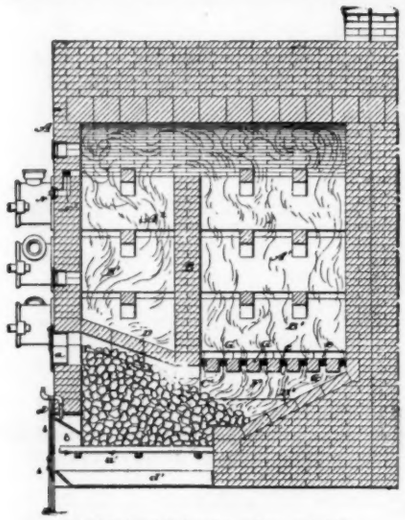

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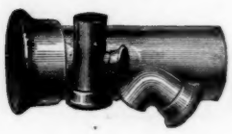

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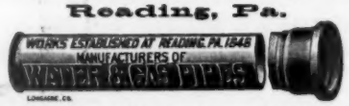

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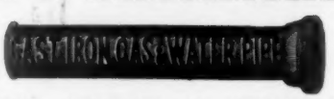

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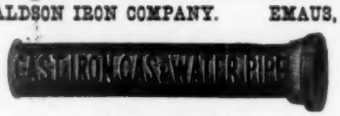

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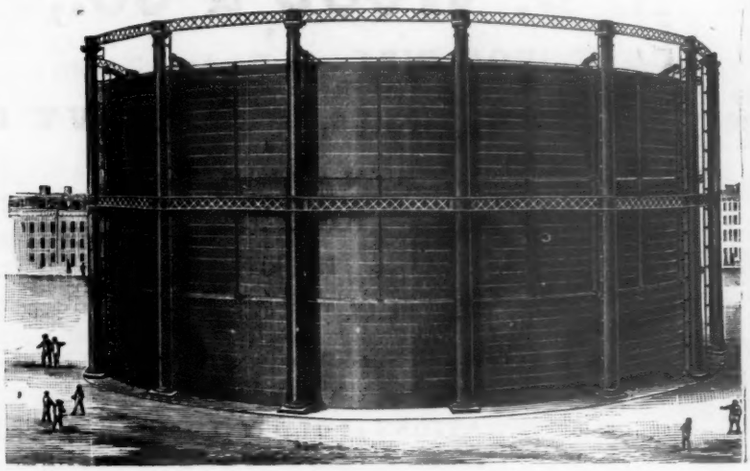

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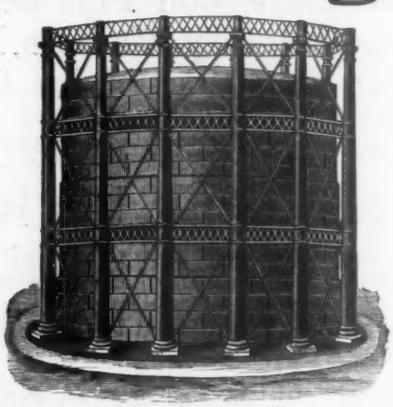

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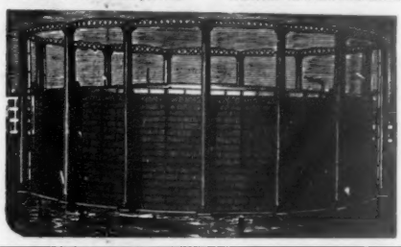

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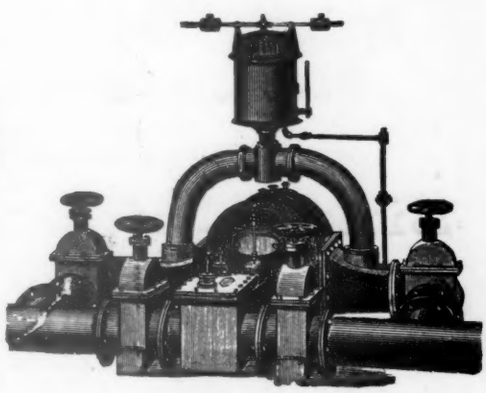

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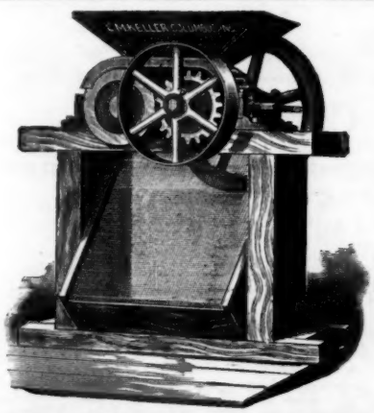

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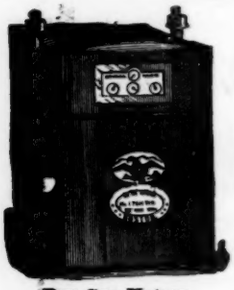

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In Theory the Otto Gas Engine realizes 18 per cent. actual work out of number of heat units in fuel consumed, while the ordinary steam plants reach but 12 per cent. **In Practice** a comparison of cost in dollars and cents between gas and steam power stands as follows (the figures below being taken from actual experience):

50-H.P. STEAM ENGINE AND BOILER, Running a Plant of Fifty 2000-C.P. Arc Lamps 12 Hours.		50-H.P. OTTO GAS ENGINE, Running a Plant of Fifty 2000 C.P. Arc Lamps 12 Hours.	
4,500 lbs. Indiana nut and slack, at $1.30 per ton	$2 93	9,200 cu. ft. gas, at 42 cts. per M. (for cost of gas see items below)	$3 86
Engineer, one night, at $50 per month	1 67	Engineer not needed; engine is in care of Electrician or Supt.	....
Trimmer, one day, at $40 per month	1 33	Trimmer, one day, at $40 per month	1 33
Superintendent or Electrician, one day, at $50 per month	1 66	Superintendent or electrician, one day, at $50 per month	1 66
Waste, etc., one day, at $20 per year	05	Waste, etc., one day, at $20 per year	05
Water rent, one day, at $40 per year	11	Water rent dispensed with (cooling water used over and over)	....
Wheeling coal and removing ashes, at $4 per week	58	Handling of coal included in cost of gas	....
100 pairs carbons, at $18.50 per 1000	1 85	100 pairs carbons, at $18.50 per 1,000	1 85
One pint cylinder oil, at 60 cents per gallon	07	One pint cylinder oil, at 60 cents per gallon	07
One quart engine and dynamo oil, at 50 cents per gallon	13	One quart engine and dynamo oil, at 50 cents per gallon	13
Total	$10 38	Total	$8 95

Expenses of depreciation, repairs, and interest omitted, being considered the same in both cases—though depreciation and repairs are much higher with steam on account of boiler and its appurtenances. Cost of gas in the holder we estimate for most of the Middle and Western States as follows: Coal, 30 cts.; labor, 20 cts.; purification, 2 cts.; total, 52 cts. Less coke, 7 cts., and tar, 3 cts.; leaving net cost of gas 42 cts. The items of Superintendence and repairs, being paid for by the gas sold to consumers, need not be charged on extra output for gas engine consumption. Where the cost of gas is higher than here figured, coal for steam use will be found proportionally higher, and final figures of comparison show same amount of saving.

Excess in Cost of Steam over Gas Power is thus $1.43, or nearly 16 per cent.

Coal for getting up steam and banking fires is not included in above figures, and should be added, thus increasing rate of economy of gas power beyond that shown by our figures.

Where Gas Companies adopt Gas Power for Electric Plants, Water Works, Sewerage, etc., they not only choose **the most economical power for their use,** but secure to themselves the **numerous advantages of increased production,** without increase of expense, and benefit thereby their entire manufacture. They induce consumers, by their example, to abandon Steam for Gas Power, and, by establishing special rates, make

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